RP 295

NATURE

No 4236 SATURDAY, JANUARY 6, 1951 Vol 167

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO, LTD,
ST. MARTIN'S STREET, LONDON, W C 2.
Telephone Number Whitehall 8831
Telegrams Phusis Lesquare London
Advertisements only should be addressed to
T G Scott & Son, Ltd, Talbot House, 9 Arundel Street, London, W C 2
Telephone Number Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

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THE UNIVERSITIES AND ADULT EDUCATION

ALL the universities and university colleges of Great Britain have defined areas within which they are responsible—in collaboration with local education authorities,, the Workers' Educational Association, and other bodies—for providing educational services to adults Large sums of money are spent upon these extra-mural activities, and many members of staff, both full-time and part-time, take part in them Yet their nature and extent are often imperfectly understood, and, in a recent article, Mr W E Salt, director of the Department of Adult Education in the University of Bristol, tries to sketch the growth and present extent of the universities' concern in adult education (*Univ Rev*, 23, No 1, September 1950)

It was in the 'seventies that the universities as institutions began to recognize responsibilities to the communities outside their walls Before that time individual members had often taken part in the contemporary movements for adult education An example is that of Dr George Birkbeck, whose lectures to mechanics in Glasgow at the opening of the century are thought to be the forerunner of the mechanics' institutes

The stirrings of new life in Oxford and Cambridge about the middle of the century caused them to look abroad, and several schemes, grouped under the phrase 'university extension', were proposed for carrying the university to the people They were first given practical effect and support by Cambridge, which, in 1873, adopted Mr James Stuart's suggestion and organized a number of lecture centres. These were followed by London and Oxford in 1876 and 1878, in 1914, all the universities of England and Wales had their extension schemes

As time went on, however, many students, particularly those drawn from the trade union and co-operative movements, felt that extension lectures did not wholly satisfy their needs They wanted, not courses of lectures, but an opportunity to make a continuous and searching study of some subject This involved a class, restricted in size, meeting regularly over a fairly long period and led by someone who would be a tutor rather than a lecturer The Workers' Educational Association, founded in 1903, pressed this point of view and took the initiative in convening a conference at Oxford in 1907 Out of it came the three-year tutorial class which is still the finest flower of British adult education The two historic tutorial classes, begun at Longton and Rochdale in 1907, multiplied to 145 in 1914

In 1919 appeared the important final report of the Adult Education Committee of the Ministry of Reconstruction The Committee concluded that the assumption by universities of new responsibilities for the higher education of adults had not been the result of any deliberate re-consideration of the principles and objects of university education It had been undertaken piecemeal in response to the demands of particular groups of students In the opinion of the

Committee the period of experiment was over It was convinced of the depth and persistence of the demand for adult education and argued for a correspondingly bold and generous use of university resources From many recommendations, three may be mentioned

1 The provision of a liberal education for adult students should be regarded by universities as a normal and necessary part of their functions

2 Their expenditure on the promotion and provision of adult education should be largely increased

3 Universities should establish departments of extra-mural studies, with academic heads and adequate staffs

In the following years, all these recommendations were carried out

The two decades between the World Wars was a period of substantial growth, in which established types of work were carried much further and ventures were made into new fields The emphasis continued to be upon courses of study and upon the repair of defects in earlier education

The Second World War was a severe test of the tenacity of students and the resilience of extra-mural departments The remarkable feature was that the unavoidable recession—greater in some areas than others, because of the unequal impacts of the War—was everywhere so limited Indeed, the work done by universities for adults actually increased because they were called upon to play a prominent—in some places, the dominant—part in the civilian contribution to Services' education Surprising numbers of lectures, courses and classes were arranged for all types of groups, varying in size from the small searchlight detachment to a whole ship's company The end of the War found adult education in Great Britain in much better shape than it had been in 1918

In the past four years, adult education has sprung forward after the temporary setback of the War Several influences have spurred it on Universities have formed closer ties with their regions, and, while drawing in from them students and resources, have felt more keenly the responsibility to give out intellectual guidance The Education Act of 1944 made it an obligation upon local education authorities to provide comprehensive schemes of further education and enjoined them to collaborate with universities in the task The Ministry of Education, a generous supporter of adult education before the War made development easier by introducing even more liberal and elastic regulations governing grant-aid The University Grants Committee, too, gave its approval and support to schemes of expansion The effect of these influences has been a noteworthy widening of the scope of extra-mural activities

No two areas show exactly the same trends or rate of growth Regions differ in their social characteristics and populations, and universities in their policies and resources But underlying these divergencies there are several common features The extra-mural programmes of all universities show the following activities, although they may be compounded in different proportions

1 *Classes in liberal studies* Three-year tutorial classes have more than held their own, and to them has been added a large number of courses running for a single session

2 *Lecture courses* Extension lectures, which had suffered a relative decline between the Wars, have revived

3 *Specialized courses* There are many people with specialized interests, mostly—though not all—based upon professional groupings Universities have, therefore arranged an increasing number of courses for such groups, mostly of a postgraduate standard Internal departments have joined with adult education departments to give teachers, engineers and industrial scientists—to mention only a few examples—refresher courses and accounts of recent advances and researches

4 *Residential adult education* The summer schools, so highly successful in pre-war days, have been re-opened and extended, and give large numbers of men and women an opportunity of continuous guided study for periods of one or two weeks, or longer

5 *Services education* In the past year, universities, which were the mainstays of the war time Regional Committees for Education in H M Forces, have, at the request of the Service Departments, assumed a more direct responsibility for the provision and co-ordination of education for men and women in the Forces

This summary shows how varied the extra-mural functions of the universities have become and serves as a basis for the discussion of problems of policy and administration Some of them are primarily administrative and raise no questions of principle Others involve the whole attitude of the university towards its extra-mural constituency

The question whether universities should engage in adult education at all is still sometimes debated The latest report of the University Grants Committee mentions the persistence of doubts concerning the quality of much extra-mural work and the difficulty of integrating it fully into the life of the university Both points have their force, but scarcely enough to warrant an adverse verdict As long as universities are teaching institutions and not just monasteries of learning, still more if they wish to become intellectual foci of their regions, they cannot ignore the needs of those members of the surrounding community who are unable to enter the walls

The conclusion that adult education is a normal function of a university leaves unresolved the problem of the scope of the work which can be properly and effectively undertaken Universities should not be universal providers, seeking to satisfy all demands, but it would be difficult to say where the limit should be set Each university decides its own policy, and the makers of policy do not speak with one voice It has been suggested that education in extra-mural courses should be limited to students who have passed their preliminary courses or can satisfy certain general educational requirements This would exclude many promising students, and Mr Salt suggests that the course itself provides the best test, it should make such demands that only the serious student is willing to accept its discipline

Similarly, it is impossible to define the scope of extra-mural studies in terms of the ultimate objective of the courses provided Some courses are intended to prepare for an academic diploma or certificate One can, in such cases, readily judge the suitability of a syllabus and can test the response of students by examination But courses of this kind are few The great majority have no such specific end They are intended, not to prepare for an examination, but to develop minds and personalities When the goal is so indeterminate, there is no simple criterion by which to judge whether the course is appropriate to a university or whether a particular student is likely to benefit by it

Thus, while the factors of duration and student attainment must be taken into account, they give little help to the formulation of policy Extra-mural committees and staffs must approach the task of building up programmes without hard and-fast principles to direct them

Secondly, all that a university does should be of high academic standard This is partly a matter of the scholarship of the lecturer or tutor It need scarcely be said that a university should be jealous of the quality of the teachers who represent it to large sections of the general public So far as members of the university staff are concerned, there is no serious problem , it is when, with the spread of the work, recourse is had to part-time tutors that the danger of uncertain standards creeps in

Another problem of some complexity is that of the relation of a department of adult education to the university as a whole If the work of this department is to be truly an extension of the university, it must be an integral part of the university body If it is not, if it does not reflect outside the walls the standards and traditions which prevail within, then it does not contribute anything which could not be as well supplied by other bodies Here it follows that as much as possible of the extra-mural work should be done by members of the internal staff They are the core of the university, and who can better transmit to the outside world the intellectual attitudes and ideals of a university than those who are their guardians ?

But complete reliance upon internal resources would very straightly restrict the scope of the work Internal lecturers have neither the time nor—very rightly—the inclination to undertake more than a limited number of outside commitments

Full-time extra-mural staffs are necessary, if only to provide a firm foundation for the local scheme and to ensure that centres remote from a university are served The right balance between the use of internal and full-time extra-mural staffs will be affected by the volume of the work and by geographical and transport factors , but decisions about the relative strengths of full-time and part-time staffs should not be made solely on grounds of administrative convenience

There is also the problem of ensuring that the full-time tutor shall feel himself to be truly a member of his university This is not merely a question of status, but how to secure that the full time tutor, resident maybe forty or fifty miles away, lacking regular contacts with fellow-students, working in isolation with groups which may rarely come under the guidance of other teachers, is made to feel that he is one of the university community, responsible for representing its ideals and policies and able to draw help and encouragement from the centre

Mr Salt also touches upon the problems for university extra-mural departments raised by the Education Act of 1944, which places upon local authorities the duty of ensuring that "adequate facilities for further education" are provided From having powers, they now have duties This change means two things local authorities will become larger providers of further education than ever before, and they are now trustees, as it were, for their citizens, charged with ensuring that comprehensive educational facilities are available This will involve close liaison between the universities and the national system of education

THE LIFE OF VERTEBRATES

The Life of Vertebrates

By Prof J Z Young Pp xvi+767 (Oxford Clarendon Press , Oxford University Press, 1950) 42*s* net

THIS is perhaps the best text-book of vertebrate zoology that has yet been written, and as there are already several good text-books on the subject, this distinction has not been easily achieved The prefaces of most text-books take pains to make clear the didactic principles on which the books were written—the need for animating structure by some reference to function, maybe, the evidence of design in the workings of Nature, the documentation of the evolutionary process, the philosophic wholesomeness of the organism as a whole, and so on Prof Young's expressed intention is to treat of the *life* of vertebrate animals in its most complete synoptic sense its origin and secular changes of complexity, the means by which animals cope with the hazards and exigencies of living and staying alive, the varieties of truce that accommodate the chronic enmity of the environment, and everything else that is entailed by the act of living The scheme as a whole is one the merits of which scarcely admit of argument, given the knowledge and grasp to see it through Prof Young evidently has these qualifications, for no other text-book of vertebrate zoology has quite the same compass or synthetic power or so easily handles the concurrent time-scales of eons and generations, years and days and minutes Yet his book is most easily and enjoyably readable, and has fewer passages of *recitativo secco* than one expects to find in a work that is obliged to be so largely descriptive in its make-up

The way in which Prof Young deals with the Amphibia will illustrate his method First, he describes the peculiar advantages of lungfish-like animals in the drying waters of Devonian times and shows how the modern Amphibia may well have taken origin from them There follows a conspectus of early and extant forms and their varieties of habit and habitat, a survey that is greatly filled out in the succeeding chapter The skin and its coloration are then dealt with fully , but it is the section on the skeleton and muscular system that illustrates the power of his method best The section is lengthy and anatomically quite detailed, but it is never gratuitously anatomical The skeletons that are described are of animals that squat or jump or swim or wriggle, that have to face the new problems of four-footed locomotion and of raising their bodies from the ground Respiration, circulation, behaviour and the nervous system are dealt with in the same spirit this is not functional morphology or physiology with an anatomical substratum, but a form of treatment that challenges the appropriateness of the conventional distinction between the two

The second of the two chapters given to Amphibia describes their evolution and adaptive radiation, and one ends with a better grasp of the biology of Amphibia than other text-books have yet contrived to provide Much use is made of very competent drawings throughout, sometimes to give a hint of an animal's characteristic surroundings, sometimes to illustrate adaptive radiation and species differences, but most often simply to show the reader what a particular animal looks like Indeed, animals peer at the reader or at each other all through the book The ill-informed reproach that the study of animals is now unfashionable among zoologists can now be finally silenced

It is characteristic of the author's manner of thought that a long chapter should be given to fishing and fishing problems and the food-cycles of the sea, which have a certain massive simplicity and grandeur If one asks, why fishing rather than live-stock raising, the answer is simply that fish are the only wild animals used in important quantities for human food Formal embryology is not included, a modern text-book of comparative embryology remains, therefore, a most urgent need Its omission was clearly a matter of policy, but there are plenty of other omissions of matters of fact that one reader or another might rightly or wrongly hope to find No doubt there are also a fair number of factual errors, the correction of which will give deep satisfaction to those who read the book with their detection as a principal motive But by and large, this is a book which stands a very good chance of outliving its author, for, as with the physiologists' "Starling", the factual matter may be partly superseded, but the framework and the habit of thought that gave the facts their order deserve to linger on

ELECTRICAL INTERPRETATION OF INORGANIC CHEMISTRY

Molecules and Crystals in Inorganic Chemistry

By A E Van Arkel Translated by J C Swallow Pp ix+234 (London Butterworth Scientific Publications, Ltd, New York Interscience Publishers, Inc, 1949) 17*s* 6*d* net

THE English translation of Prof A E Van Arkel's book on "Molecules and Crystals in Inorganic Chemistry" will be of particular value to the chemist and crystallographer Van Arkel was one of the pioneers in using an essentially electrical model of the atom to explain chemical phenomena

In his book he has given a systematic account of inorganic chemistry based on these ideas Fundamentally, he used as assumptions the existence of positive and negative ions variously charged and with definite atomic radii. He explains the structure and stability of molecules of extended crystal lattices by considering the electrostatic Coulomb energy between the charged ions By making use of knowledge of ionization potential and electron affinities derived from electrochemical studies, it is possible in this way to calculate, in a very large number of cases, the energy of formation of a compound and to indicate, where he cannot do so, the relative parts of different structures In this way he covers and extends the work of Pauling and Goldschmit In later chapters he considers the particular position of the hydrogen ion existing within the electron cloud of other ions, particularly those of oxygen, and the effects of polarization Van der Waals forces, covalent bonds and inter-metallic forces are mentioned but not developed

The attractive feature of Van Arkel's view of chemistry is its coherence and its simplicity. By the use of an extremely simple hypothesis and no mathematics beyond that of adding and dividing, he is able to produce a quantitative picture of stability and energies of compounds which does not differ grossly from experimental values He is able, as well, to explain many of the features of inorganic chemistry such as solubilities and volatility In this way inorganic chemistry ceases to be a set of particular facts to be learned and remembered, and becomes a rational discipline to be deduced from first principles The refinements of quantum theory would undoubtedly give a far more adequate picture of inter-atomic energies This, however, is only possible by the use of the most refined mathematics, which achieves results of little greater accuracy It would appear that the simple approach is of the greatest value for getting a general view over the field and particularly for introducing students to it, as long as they are carefully warned that this is not the whole story and that the finer aspects of chemistry, both of molecules and crystals, require much more detailed treatment

The book will be of great value to chemical and crystallographical students and undoubtedly will form part of the revision of the elementary inorganic chemistry that is now in progress J. D Bernal

THE CHEMICAL ENGINEERS' BIBLE

Chemical Engineers' Handbook

Prepared by a Staff of Specialists Dr John H Perry (editor) (McGraw-Hill Chemical Engineering Series) Third edition Pp xv+1942 (London McGraw-Hill Publishing Co, Ltd, 1950) 144*s* 6*d*

THE "Chemical Engineers' Handbook" has reappeared in a new shape, 8 in × 6 in as compared with 6 in × 4 in, the pages being reduced in number from 3,029 to 1,942 The alteration is, in most respects, to be highly commended The old edition was uncomfortably thick and with narrow margins, with the result that much of the subject-matter was difficult to read and many of the old charts were too small to be of much quantitative value The larger pages make possible the provision of really useful diagrams, and the 2,081 figures have all been improved by printing from new blocks Some of the tables have suffered in appearance by horizontal extension without appreciable vertical change, especially logarithms and the tables of physical properties In the case of organic compounds, the long blank spaces might well be filled with values for the refractive index, a quantity often required for analytical purposes

"Perry" would be a good answer to those who still ask the question "What is chemical engineering ?" It deals with nearly all that a chemical engineer may want to know, whether in the form of numerical data, fundamental theory or the performance of plant The quality is on a level with the quantity, since every article is written by an acknowledged expert in its subject-matter

The book is still divided into thirty sections , but those on arithmetic, analytical chemistry and organic chemistry have gone New articles on diffusional operations, furnaces, size enlargement and distillation are very welcome, while the rewritten section on process control deserves special mention for its clarity and conciseness Any detailed review of the vast amount of material presented is impossible , it is easier to direct attention to a few minor defects in the hope that they may be eliminated in future editions

A volume of this comprehensive nature is particularly liable to what may be called the persistence of obsolete data An example is a table of sparking potentials taken from an American text-book of 1928 The actual figures appear to be mainly those of Warburg (1890) and Defregger (1903), which are quite unreliable On the whole, however, the book is remarkably free from inaccuracies of this type, the authors having taken great pains to insert the most recent figures available and to give their origin

The transfer of tables from other publications *en bloc* is not always desirable The chemical engineer is not interested in the coefficient of expansion of the Jena thermometer glasses or of topaz (p 201), whereas he might like to find some figures for refractories, which are only referred to in a very sketchy manner , values for the electrochemical equivalents of the rare gases (p 1,776) are meaningless In the section on materials of construction, the extensive tables with their liberal use of trade names could, with advantage, be greatly abbreviated, particularly in view of the very proper warning that corrosion figures are unreliable A feature which it is hoped will not be developed further is the emphasizing of the names of makers of machinery rather than the principles of its operation Certain subsections tend to resemble a collection of catalogues, and many of the illustrations give no useful information as regards constructional details

Points such as these are, however, of quite minor importance, and the volume as a whole must be regarded as an admirable summary of existing knowledge which every chemical engineer will feel it is his duty to possess H E WATSON

NUCLEAR PHYSICS FOR THE NON-SPECIALIST

Einfuhrung in die Kernphysik

Von Prof Dr Wolfgang Riezler Vierte erweiterte Auflage Pp 309+8 plates (Berlin und Buxtehude Hermann Hubener Verlag, 1950) n p

DR RIEZLER's book is meant for the non-nuclear physicist, the student and the educated layman It is descriptive and avoids any derivation of formulæ, though some of the more important relations are scattered throughout the text The book is arranged as follows properties of nuclei, natural radioactivity, nuclear transformations, basic ideas of the build-up of nuclei, together with systematics and a little theory The second half of the volume deals with the methods used in nuclear investigations, such as the ways by which one obtains fast particles, neutron sources like the pile, and methods of detecting particles such as ionization chambers, counters and associated circuits, etc A chapter on applications connected with the use of radioactive isotopes, a simple graphic representation of the radioactive isotopes and a glossary complete the volume The book runs to about three hundred pages and contains most of what is noteworthy up to the spring of 1948 The presentation is, on the whole, clear, though the text is occasionally uninspiring If a reader is supposed to follow through three hundred pages of text, it would certainly make it easier if the author had given an inkling of the dramatic developments which take place in science, and which sometimes, so to say, overnight, bring us an enormous step forward A very good idea of what this means can be obtained from Pauli's contribution to the Bohr jubilee number in the *Review of Modern Physics*, where he deals essentially with the development of the quantum theory

Since the volume is meant for laymen, Dr Riezler has added a glossary If, however, a reader has to look up the meaning of "ohm", "gleichrichter" or "kondensator", he has very little chance of getting further in this book than the introduction, since he collides later on with such formidables as the quadrupole moment, Larmor frequency, uranium Z and circuit diagrams with heaps of components It is not the name, superficially explained in a line, which is hard to grasp, but the visualization of the meaning, which is often very difficult Therefore, this glossary scarcely helps and might just as well be dropped in future editions

There is a number of points about which I could quarrel with the author , here are a few selected at random A minimum length is postulated in nuclear theory, on p 144, but the Pauli principle, which is so fundamental for nuclear structure, is forgotten. Nothing is gained by giving three circuit diagrams of electronic scalers (pp 209–11), nor is the linear amplifier without feedback representative of modern electronic design (p 196) The positive ion sources in high-voltage equipment of to-day are almost exclusively low-voltage discharge tubes or radio-frequency sources and not canal ray tubes (p 153) No nuclear research was done with the old linear multiple accelerator (pp 153–4), though the modern version of Alvarez is quite successful The great success of modern medium-energy accelerators is the linear accelerator for electrons, which is not mentioned

Finally, the collection of names in the author's index makes strange reading It often seems that the names have been chosen at random, leaving out well-established men of science such as C D Anderson, Blackett, Frisch, Meitner and others To say that the relation $E = mc^2$ is, in the literature, referred to as Hasenohrl's and sometimes as Einstein's is unfair, since I could not find this statement elsewhere though I went through several text-books, some of them in German That Einstein's relation is the result of a new law of Nature and of universal validity, while Hasenohrl's is from ordinary classical electro-magnetic theory and is no more than an interesting remark, seems to have escaped the author

Some of the photographs at the end of the book are very unsatisfactory the one of the cyclotron of the Collège de France is not good enough—it is out of focus E BRETSCHER

Technique of Organic Chemistry

Edited by Arnold Weissberger Vol 3 Heating and Cooling, Mixing, Centrifuging, Extraction and Distribution, Dialysis and Electrodialysis, Crystallization and Recrystallization, Filtration, Solvent Removal, Evaporation and Drying Pp ix+661 (New York and London Interscience Publishers, Inc , 1950) 80*s*

THIS volume surveys the techniques used in the isolation and purification of compounds, and is the third in an Interscience Series of which the first, dealing with the measurement of physical properties, is now well known

The articles by the various authors differ greatly in length The chapters on extraction and distribution and on crystallization and recrystallization occupy 142 and 122 pages respectively, that on solvent removal, evaporation and drying occupies thirty pages, and that on centrifuging requires merely twenty-eight pages The selection of material for certain of these articles appears to have presented a difficult problem, and in some chapters a rather peculiar balance has been struck between chemical engineering theory and laboratory technique For example, in the section on heating and cooling (98 pages) a short account is given of the chemical engineering approach to heat transfer theory, and later in the same article space is devoted to bunsen and other burners with descriptions and illustrations such as can normally be found in laboratory furnishers' catalogues The chapter on filtration (120 pages) is similarly constructed

The articles on extraction and distribution, written by L C Craig and D Craig, and on crystallization and recrystallization, by R S Tipson, give very useful surveys of the literature and contain European as well as American references

The binding conforms to that of the earlier volumes, and, while the price may deter individuals from purchasing this work, yet the book will probably find a place in most scientific libraries E F G H

Ore Genesis

A Metallurgical Interpretation, an Alternative to the Hydrothermal Theory By Dr John Stafford Brown Pp 204 (London Thomas Murby and Co , 1950) 12*s* 6*d* net

IN this stimulating book, first published in the United States, a serious challenge is offered to the established hypothesis that most sulphide ore deposits were precipitated from aqueous solutions, the last residues of consolidating magmas Dr J S Brown argues that the agreed facts of paragenetic order among sulphides could be explained were the minerals derived from an anhydrous sulphide magma, stratified like the immiscible layers in a non-ferrous smelting furnace (from top to bottom slag, matte, speiss, galena-lead) Gaseous transfer is postulated, aided by water only at epithermal levels The sulphide magma is pictured as a global layer beneath the basaltic shell, formed during primeval differentiation by separation of immiscible liquids, settled upon the top of an already-crystalline peridotite substratum The primary oxide ores are considered to come from magma-pockets higher in the sima To the end-stages of granitic plutonism are ascribed only the pegmatites Gangue minerals—boron, fluorine and barium minerals excepted—come from the country rocks

The physical data presented reveal the need for investigation of the vapour phases of the sulphides and oxides under high pressure The idea of hypothermal and even mesothermal mineralization by vapours will be more favourably received in Great Britain than in Dr Brown's own country, for the British have not abandoned their belief in pneumatolysis , indeed, some British petrologists ascribe far greater importance to diffusing fluids than is here implied That the peridotite substratum was crystalline before the sial and basalt layers is harder to reconcile with current views on the primordial earth
K C Dunham

Practical Physics

A Collection of Experiments for Upper Forms of Schools and Colleges together with the Relevant Theory By Sir Cyril Ashford Pp xii+175 (Cambridge At the University Press, 1950) 10*s* 6*d*

FOR most of this collection of experiments for upper forms of schools and colleges, the author has used problems set during the past fifteen years in the higher school certificate papers of the Cambridge University Local Examinations Syndicate, and has transformed and amplified them to fit into a teaching course Although the fifty experiments included deal with all branches of physics with the exception of sound, the book is not adequate for a normal two-year course such as is usually carried out in schools, nor is it suitable for this purpose Its greatest value would be to the more brilliant and scholarship pupils in their last year at school, for they would undoubtedly derive great benefit by performing the experiments and following the excellent treatment of results given by the author

The student is invited, not merely to do the experiment for the sake of practice in experimenting, but to act more as a pioneer who obtains results and then analyses them exhaustively , the writer thinks this is the right course to adopt A very valuable introduction is provided dealing with the reduction of observations, and stress is laid on graphical methods with particular emphasis on linear equations Altogether this is an excellent book which should be in the hands of all teachers of physics

Principles of Human Geography

By P Vidal de la Blache Edited by Emmanuel de Martonne Translated from the French by Dr Millicent Todd Bingham (Reprint) Pp xv+511+6 plates (London Constable and Co , Ltd , 1950) 20*s* net

PROF P VIDAL DE LA BLACHE died in 1918, several years before this book was originally published The translation first appeared in 1926, and the present volume is a reprint of that book It says much for an unfinished book that it can bear unaltered reprint twenty-four years after its original appearance But no other book on human geography has quite the standing of this volume, with the author's width of knowledge and wealth of examples of his principles In the original manuscript, Prof E de Martonne had to correct minor mistakes and smooth out confused statements But this could be done, and, despite a few obsolete statements and doubtful facts, the book is homogeneous and reliable Prof Vidal de la Blache surveys the world from a historical and evolutionary point of view At times he is assertive , but he is always vivid and illuminating Towards the end the book is fragmentary and all the more suggestive to the serious student There are several maps showing various distributions It is a book free from jargon and one that the general reader can easily follow, while no serious student of geography can afford to neglect it R N R B

SCIENTIFIC CENTENARIES IN 1951

By Engineer-Captain EDGAR C. SMITH, O.B.E., R.N.

AMONG the centenaries of 1951, that of the Great Exhibition of 1851 will in Great Britain overshadow all others in general interest. Unlike the Festival of Britain, the Exhibition had little backing from the Government of the day, and it was Mr. (afterward Sir) Henry Cole who remarked that "a great part of the success which has attended the institution of this Exhibition may be attributed to its independence of the Government; and it may be the boast of our countrymen, that the Exhibition was originated, conducted and completed independently of any Government aid whatever, except its sanction. . . ." The Queen, it is true, appointed a Royal Commission "to make full and diligent inquiry", but no Government department was represented on it as such. Many men of science and engineers were, however, on the Commission, these including the Earl of Rosse, president of the Royal Society, Sir Charles Lyell, president of the Geological Society, and William Cubitt, president of the Institution of Civil Engineers. Scott Russell, the shipbuilder, was one of the secretaries of the Commission, and Robert Stephenson was appointed chairman of the Executive Committee.

There were many critics of Paxton's famous building for the Exhibition, and when its design was discussed at the Institution of Civil Engineers, Airy, the Astronomer Royal, as he wrote, "expressed himself strongly on the faulty principles of its construction". Criticisms came from many quarters. Some people said that it would fall from sheer weight or from vibration, others that the heat of the sun would cause the iron columns to be pushed out of line, while others thought that gales would blow it down. Destruction of the glass, it was feared, would come through the firing of cannon in Hyde Park or through the playing of orchestras and the organ. Yet another criticism was that a hailstorm would leave the whole of the roof without glass. As is well known, none of these things happened, and the Crystal Palace, on its later site at Sydenham, finally came to its end in 1936 through fire.

As time passed, many other men of science besides those already mentioned became connected with the Exhibition in one way or another, one of the most active being Mr. Lyon (afterwards Lord) Playfair, and various interesting sidelights on the Exhibition and the scientific world can be obtained from the memoirs of Playfair and others. Included in the long list of jurors was Sir David Brewster, who was greatly interested in the Kohinoor diamond. This famous gem, when exhibited, at first caused disappointment; but at Brewster's suggestion "fifteen or sixteen gas lights were placed behind it", when it "threw out a radiance of coloured light which delighted all who saw it". One day Brewster made the acquaintance of Charlotte Bronte, "a pleasing little woman about forty, modest and agreeable", and he accompanied her through the Exhibition. The work of a juror did not, however, exhaust all Brewster's energies, for on July 22 he presided over and addressed a Congress of Peace in the once famous Exeter Hall, which stood where the Strand Palace Hotel, London, is now.

One of the most vivid chroniclers of the time was the geologist Sir Andrew Ramsay. In January 1851, there was a jovial dinner of the Royal Hammerers at which Sir Henry De la Beche, Edward Forbes, Warington Smyth, James Forbes, Playfair and others were present. When Ramsay and Forbes joined in, the fun was fast and furious. A bit later there was the anniversary dinner of the Geological Society, at which "Sedgwick made the great speech of the evening. By turns he made us cry and roar with laughter as he willed." Then the "Red Lions", some of whom had monthly meetings in London, got mixed up with a dinner to the Press of all nations, for which half an ox was roasted in the garden and then carried in by twelve cooks, the band playing "The Roast Beef of Old England". In sterner mood, Ramsay recorded the opening on March 12, by the Prince Consort, of the School of Mines and Museum of Practical Geology, in Jermyn Street, London. De la Beche was president of this institution, and the staff consisted of Playfair, Edward Forbes, Robert Hunt, John Percy, Ramsay and Smyth.

In those days, at Cambridge, Stokes was Lucasian professor, Challis was Plumian professor, Peacock was Lowndean professor, as well as Dean of Ely, while Sedgwick was Woodwardian professor. As Master of Trinity, Whewell had already attained that dominating position in the University which led someone to write:

> "You may roam where you will through the realms
> of infinity
> And meet nothing so great as the Master of
> Trinity".

Science at Oxford was still somewhat in the doldrums, but among men of distinction there were Baden Powell, Savilian professor of geometry, W. F. Donkin, Savilian professor of astronomy, Daubeny, professor of chemistry, while Buckland was reader in geology and also Dean of Westminster, a position he held from 1845 until 1856. Under him the Deanery became a meeting-place for literary and scientific men and engineers, Liebig being among his visitors in 1851. During the Great Exhibition, the Dean's son, Frank, then a medical student, with two companions climbed to the roof of the nave of Westminster Abbey and hung therefrom a Foucault pendulum. It was suspended just opposite the door to the Deanery and swung over a dial on the pavement.

The Royal Society at that time was still housed in Somerset House, and it was there in 1851 that Owen received the Copley Medal and Faraday read one of his papers on the lines of magnetic force, a subject which he said "has at different times been greatly influential in leading me to various results which I think prove their utility as well as fertility". Close to Somerset House, in King's College, Wheatstone, as professor of experimental philosophy, was adding to his reputation though doing little lecturing; in Oxford Street, the Royal College of Chemistry was under the guidance of the great Hofmann, while the University of London saw the labours of such as Thomas Graham and Augustus de Morgan. Connected with the various institutions were Sir John Herschel, then Master of the Mint, Darwin, who had been settled at Down, Kent, for nine years, and two young medical men, Huxley, who at the age of twenty-five had not long returned from his long commission in H M S *Rattlesnake*, and Lister, his junior by two years, who was still a London student But none of these was more interested in the Exhibition and its wealth of manufactures and machinery than Babbage He had been disappointed at not being placed on the Royal Commission, and still more disappointed that his famous calculating machine—then Government property—was not on show, but he had his compensations, and records that "I frequently accompanied the Duke of Wellington to the Exhibition or met him there by appointment at the Crystal fountain" To Babbage was due the volume, "The Exposition of 1851, or Views on the Industry, the Science and the Government of England"

There had been many Expositions, especially in France, before 1851, but none with such a wide scope and none planned with such high hopes At a banquet at the Mansion House, London, on March 20, 1850, the Prince Consort, referring to the coming Exhibition, said "nobody, however, who has paid any attention to the particular features of our present era, will doubt for a moment that we are living at a period of most wonderful transitions, which tends rapidly to accomplish that great end—to which indeed all history points—the realization of the unity of mankind The distances which separated the different nations and parts of the globe are gradually vanishing before the achievements of modern invention and we can traverse them with incredible speed, the languages of all nations are known thought is communicated with the rapidity, and even by the power, of lightning On the other hand, the great principle of the division of labour, which may be called the moving power of civilization, is being extended to all branches of science, industry and art " Journals and periodicals all joined in the chorus of approval, and when the Exhibition was open, vied with each other in their laudatory reviews "What has antiquity to show," said the *Athenæum*, "in comparison with the scene in Hyde Park? The noblest congresses of the ancient world look narrow, insular and local by its side The Crystal Palace knows no difference between Jew and Greek, Frank and Saxon In that arena for the first time in the annals of mankind, the Negro, the Malay, the Sclave and the American, will stand together on equal terms, and merit, of its kind, will carry away the honours of genius and industry, without reference to questions of blood, type or colour This is a starting-point for the true theory of the equality of nations—a new era in the history of progress "

Though the Exhibition contained wonderful displays of the manufactures, merchandise and raw materials of the whole world, it was, above all, a demonstration of what science, invention and engineering had achieved Among the thirty classes of objects were those devoted to railways, locomotives, steam engines, ships, machine tools, textile and agricultural machinery, chemical processes and the like There were models of bridges by Stephenson, Brunel and Vignoles, Nasmyth's steam hammers, Armstrong's hydraulic hoists, Appold's centrifugal pumps, Whitworth's lathes, Fairbairn's riveting machines, Applegarth's printing machines, McCormick's reaping machine, Snow Harris's lightning conductor for ships, a steel gun from Krupp's, models of the Bell Rock and Skerryvore lighthouses —an almost endless variety of objects One class was devoted to "Philosophical Instruments", and here the list of exhibitors included the names of Ross, Dollond, Ericsson, Bourdon, Froment, Oertling, Siemens, Merz, Ertel, De la Rue and Negretti and Zambra Electric clocks gave the time throughout the building, in which were several telegraph stations "at which boys worked Cooke's Needle Telegraph, sending messages—not too long—to various parts of London, for the charge of 1*s* "

The Exhibition was formally opened on May 1 by Queen Victoria and was officially closed on October 15, the final event being the singing of the Hallelujah Chorus There was no admittance on Sundays, and the charges for entrance were 1*s* for the first four days of each week, 2*s* 6*d* on Fridays and 5*s* on Saturdays, the last being reduced to 2*s* 6*d* from August onwards At times there were as many as 90,000 persons in the building More than £350,000 was taken at the doors, and one small item of revenue was £7 14*s* 11*d* for weather charts About a quarter of a million copies of the official catalogues were sold, which, said the *Edinburgh Review*, if piled in a vertical column on the bed of the Pacific Ocean, would rise above sea-level and "form a lonely peak rising to the height of Chimborazo or Cotopaxi" Fortunately, the Exhibition made a handsome profit, a part of which was used to purchase the market gardens to the south of Hyde Park, a tract of land now partly covered by some national museums which will play a part in the Festival of Britain

Turning from the centenary of the great event of 1851 for Great Britain to the centenaries and bicentenaries of men of science, invention and engineering which occur in 1951, the first list includes the honoured names of Oliver Lodge, George Frederick Fitzgerald, Arthur Schuster, George Chrystal, Silvanus Thompson and Francis Maitland Balfour, who were all born in 1851 There is no need to refer here in detail to their attainments and achievements. They all left their marks on the progress of science and stimulated both their contemporaries and successors The career of Sir Oliver Lodge was bound up with the fortunes of the Universities of Liverpool and Birmingham, that of Fitzgerald with Trinity College, Dublin, that of Sir Arthur Schuster with the University of Manchester, that of Chrystal with the University of Edinburgh, that of Balfour with Cambridge and that of Silvanus Thompson with Finsbury Technical College, of which he was professor of physics and principal from 1885 until 1916

The advantages of being brought into contact at an early age with men of character and distinction has often been remarked on, and no one could listen to Silvanus Thompson without carrying away indelible impressions of an eloquent, skilful and lucid lecturer His many scientific papers, his addresses, his treatises on electricity and magnetism and his linguistic attainments made his name known throughout the scientific world, and not the least of his contributions to science were his biographies of Faraday and Kelvin Sir Oliver Lodge died in 1940 at the age of eighty-nine, Sir Arthur Schuster in 1934 at eighty-three, Thompson in 1916 at sixty-four, Chrystal in 1911 at sixty, but Fitzgerald lived only to the age of forty-nine Francis Maitland Balfour died when but thirty At Cambridge, however, he had already founded an active school of zoologists, and in the spring of 1882 a special professorship of animal morphology was instituted for him A few months later, while on holiday, on July 19, he lost his life attempting to climb one of the spurs of Mont Blanc

The losses to science in 1851 were many and widespread German astronomy was the poorer by the death of Ludwig von Boguslawski, director of Breslau Observatory and known for his many observations of Bode's, Biela's, Encke's and Halley's comets, and German mathematics by the death at the age of forty-six of Karl Gustaf Jacob Jacobi, of Konigsburg and Berlin Ball said of Jacobi that "he was the greatest mathematical teacher of his generation and influenced the more able of his pupils to an extent almost unprecedented at that time" French science lost the service of Baron Buquoy, known for his researches in physical science and his many experiments on glass, and Louis-Jacques-Maudé Daguerre, the painter of dioramas and the pioneer of photography, who collaborated with both Nicéphone and Isidore Niepce On March 9, 1851, the eminent Danish electrician, Hans Christian Oersted, died at Copenhagen at the age of seventy-three, thirty-two years after he had published his paper, "Experiments on the Effect of Opposing Electricity upon the Magnetic Needle", which gained for him the Copley Medal of the Royal Society and many other honours. In 1846, Oersted had attended the Southampton meeting of the British Association, and Playfair, who met him there, wrote "Oersted was a man of peculiar fascination, being a poet as well as a philosopher He was forty-two years older than myself, but we formed a warm friendship and he corresponded with me during the few remaining years of his life"

Among the British men of science who died in 1851 were William Nicol, who, leading a retired life in Edinburgh, devoted himself to microscopic studies of fossil woods and crystals and whose name is recalled by the 'Nicol' prisms, John Kidd, the son of a sea captain who became the first Aldrichian professor of chemistry at Oxford, and who in the dark chambers beneath the Ashmolean Museum gave voluntary lectures on geology which were attended by Daubeny, the Conybeares and Buckland, and Richard Cowling Taylor, another student of geology, who came under the influence of William Smith, and, after acting as a land surveyor, in 1830 emigrated to the United States, where he did good work in exploring the iron- and coal-fields of Pennsylvania To this tale of losses must be added the name of Richard Phillips, the Quaker friend of Luke Howard and William Allen, lecturer in chemistry at the London Hospital and the Royal Military Academy, Sandhurst, editor for many years of the *Philosophical Magazine*, president of the Chemical Society and chemist to the old Museum of Economic Geology He died the day before the new Museum was opened, and Ramsay wrote "A terrible damper occurred which was kept from Sir H Faraday told Hunt just before the Prince came that poor old Richard Phillips had died yesterday It was a shock to me Strange that he should have died at the opening of the Museum I feel myself unconsciously repeating his jokes "

The record of births and deaths in 1751 brings to mind the fruitful career of the French mineralogist, Jacques-Louis Count de Bournon, who was born at Metz on January 21, 1751, and died at Versailles on August 24, 1825, while in charge of the cabinet formed by Louis XVIII. His earlier years were spent as an officer in the artillery, but at the Revolution he came to England, where his services were much appreciated in geological circles In the story of the Geological Society it is stated that "Count de Bournon had written an elaborate monograph on carbonate of lime, and in order to raise funds for its publication Dr Babington invited to his house a number of gentlemen distinguished by their zeal in mineralogical knowledge, when a subscription list was opened and the necessary sum was collected Other meetings of the same gentlemen took place for friendly intercourse, and it was then proposed to form a geological society On November 13, 1807, a meeting was held at the Freemason's Tavern, Great Queen Street, at which resolutions were passed formally constituting the Society" Only eleven were then present, but among these were William Babington, M D, F R S, and Count Bournon, F R S After the restoration of the French monarchy, the latter returned to his native country

Another Frenchman of note, but one who served in the infantry, was Claude-François-Dorothée, Marquis de Jouffroy d'Abbans, who at the age of twenty-five, in 1776, attempted to drive a boat by steam on the River Doub In 1783 he made another experiment on the Saone at Lyons, but he too had to emigrate and was absent from France for ten years or so He died a pensioner in the Invalides on August 7, 1832 A statue of him was set up at Besançon in 1884, and in 1933 a tablet to him was dedicated in the fortress of Ste Marguerite near Cannes, where he was once interned Far more peaceful were the careers of the English mathematicians Isaac Milner (1751–1820) and Abraham Robertson (1751–1826) Both came of humble parentage, both became schoolmasters and clergymen; but while Milner held the Cambridge posts of professor of natural philosophy, president of Queens' College and Lucasian professor, Robertson was during 1797–1810 Savilian professor of geometry and from 1810 until his death Savilian professor of astronomy at Oxford

Of the several notable men of science who died in 1751, Benjamin Robins and George Graham, like Silvanus Thompson and Richard Phillips, were sons of Quakers, and Graham remained a Quaker all his life Robins was born in Bath in 1707, and Graham in Cumberland in 1673, but whereas Robins became a mathematical tutor, a civil engineer, a political pamphleteer, the editor of Anson's "Voyages" and finally the engineer-in-chief of the East India Company, Graham learnt the trade of a clockmaker under the famous Tompion, married Tompion's niece, succeeded to Tompion's business in Fleet Street, London, and in November 1751 was buried in the grave of Tompion in the nave of Westminster Abbey Robins is to-day remembered as the inventor of the ballistic pendulum and the author of the "New Principles of Gunnery" (1742), while Graham is remembered for his invention of the mercurial pendulum and the dead-beat escapement, and for the many notable astronomical instruments he constructed for Halley, Bradley and others

To another branch of science belongs the name of Andrew Gordon (1712–51), who was born in Angus, Scotland He was sent to Germany at the age of thirteen and became a Benedictine monk and held the chair of philosophy in the University of Erfurt He too gained a European reputation and was made a *correspondant* of the Paris Academy of Sciences He made experiments and wrote works on electricity, and was the first to devise an electrical mach with a cylinder instead of a globe Conte with these famous men was the long-lived Polhammer, ennobled Polhem Th the North, 1661–1751", of whom an account was given to the Newcomen Society in 1926 by Mr J G A Rhodin Mining and minerals and smelting, handling plant and locks and docks were all improved by the work of Polhem, whom Charles of Sweden made 'Assessor' to his Board of Trade His "Patriotic Testament" was written when he was eighty-five, but was not published until ten years after his death

Finally, to bring this review to a close, mention may be made of Flamsteed's friend, assistant and collaborator, the Yorkshireman Abraham Sharp Born three hundred years ago at Little Horton, near Bradford, Sharp was apprenticed to a merchant at Manchester, but he became a schoolmaster at Liverpool, and it was there that Flamsteed met him He constructed a mural quadrant which, like the instruments of Graham, Bird and Troughton, is preserved at Greenwich, and Smeaton once wrote of him "I look upon Mr Sharp as having been the first person that cut accurate and delicate divisions upon astronomical instruments" The latter part of Sharp's life was spent at his birthplace, where he died on July 15, 1742, at the age of ninety-one

There are, of course, other individuals who might have been added to this sketch if space permitted Such were the German physicist, E W von Tschirnhausen (1651–1708), the French chemist, J F Clouet (1751–1801), the French-American ornithologist, J J Audubon (1780–1851), the United States Army surgeon, W Reed (1851–1903) and Sir John Jackson (1851–1919), the constructor of great civil engineering works They had at least this in common, that they believed with Lord Kelvin that

> "To know, to do, and on the tide of time
> Not to drift idly like the cockle sailor,
> Whose pearly shallop dances on the blue,
> Fanned by soft airs, and basking in brief sun,
> But to steer onward to some purposed haven
> And make new waves with motion of our own,
> That is to live".

GEOLOGICAL SURVEY OF INDIA

CENTENARY CELEBRATIONS

By Sir LEWIS FERMOR, O.B.E., F.R S

PRIOR to the formation of the Geological Survey of India as an official Department, a considerable amount of geological investigation was carried out in India by amateurs in the service of the East India Company, principally surgeons, officers of the Trigonometrical Survey, and civil administrators The work of three of these pioneers has proved to be of enduring value, namely, that of Captain Newbold, F R S, on the geology of southern India, and the joint researches of Dr H. Falconer, F R S, and Sir Proby Cautley, F R S, on the fossil vertebrate fauna of the Siwalik Hills Four of these early investigators received official appointments for geological work, namely, Laidlaw (mineralogist to the Survey of Kumaon, 1817–21), Dr H W Voysey (geologist to the Great Trigonometrical Survey, 1818–23), Captain
erfield (Malwa and the Geological Survey of the
a Mountains, 1820–22), and Captain J D
eological surveyor of the Himalaya Moun-
9) Voysey is sometimes called the
n geology

in 1846, by the Court of Directors
pany, on a recommendation
ittee for the Investigation of the Coal and Mineral Resources of India, of D H Williams as "Geological Surveyor to the East India Company" has already been discussed at length in an article by Sir Cyril Fox (*Nature*, 160, 889, 1947) When Williams died in 1848, Dr John McClelland, secretary of the Coal Committee, deputized until 1850, and, after an interval, a successor, Dr Thomas Oldham, was appointed in 1851 About this time a rival Punjab Geological Survey was begun under Dr A Fleming for the purpose of surveying the Salt Range, this Survey lasted from March 1848 until September 1852

In attempting to decide whether to date the Geological Survey of India from Williams's arrival in 1846 or Oldham's in 1851, it is necessary to remember that Williams's survey was a one-man effort, and that he nowhere uses the term Geological Survey of India, nor is this term used in official correspondence with reference to his work McClelland has confused the issue slightly by his use of this term, but it appears to have been an unofficial use, and to represent what had all along been McClelland's objective, for it must be remembered that it is mainly to his efforts as secretary to the Coal Committee that the directors of the East India Company were induced to appoint a geological surveyor Although Oldham also bore the same title as Williams, namely, "Geological Surveyor to the East India Company", nevertheless he at once started describing himself as "Superintendent of the Geological Survey of India", and this term was also used in official correspondence Moreover, he began immediately to recruit other geologists, J G Medlicott being appointed late in the same year 1851, R I St George in 1852, H B Medlicott in 1854, and W T and H F Blanford in 1855 Also, in 1853, William Theobald, who had been working with the Punjab Geological Survey until that organization ceased to function, and who had become a useful geologist, applied to Oldham for a post in the Geological Survey of India and was accepted on the basis of a new appointment in a new department

In consideration of all the interlocking and somewhat confusing data, it has been decided to treat the period 1846–51 as a preliminary one and to regard the continuous Geological Survey of India as dating from 1851 It is this centenary that is being celebrated in Calcutta this month, though the actual centennial date will be March 5, 1851

Thomas Oldham at the time of his appointment was thirty-five years of age and local director of the Geological Survey of Ireland and professor of geology in Dublin, he had been elected to the Royal Society at the early age of thirty-two He was appointed on a five-year agreement, and his office was renewed in five-year spells until he retired in 1876 after twenty-five years of service Oldham must, therefore, be regarded as the architect of the Geological Survey of India During this period he succeeded in having the strength of the Department raised to sixteen, and, in spite of a very high death-rate in the early days, an amazing amount of good work was accomplished and large tracts of India surveyed on a broad scale The early geologists included the two brothers Medlicott and the two brothers Blanford, of whom the younger, H F, left the Department early and became the first meteorological reporter to the Government of India Other well-known men appointed to the Survey during Oldham's time included William King, Bruce Foote, F R Mallet, Theodore Hughes, A B Wynne, Valentine Ball, and the palæontologists Waagen, Stoliczka, Lydekker and Feistmantel

During these twenty-five years the foundations were laid of our knowledge of Indian stratigraphy, and such famous terms were introduced as Aravalli, Cuddapah, Vindhyan, Gondwana, and some of the principal Himalayan systematic names The Talchir boulder bed was recognized (by W T Blanford) as of glacial origin and the germ of the idea of Gondwanaland thereby created H B Medlicott made his classic study of the sub-Himalayan ranges of the Punjab, and Wynne his equally classic study of the Salt Range, in which, confirming Fleming's survey, he showed that the Saline Series, underlying Palæozoic beds, is the oldest series exposed in the Salt Range, and of quite different age from the Tertiary Kohat salt, a result that has not been upset in spite of recent micro-palæobotanical research

On the economic side the chief attention was given to the survey of the Indian coalfields, mainly by W T Blanford, Hughes and Ball, Hughes being the most prominent in this Oldham also initiated the scientific study of earthquakes in India and prepared catalogues both of past earthquakes and of the hot springs of India He published the first Indian mineral statistics

During this period also was built the present Indian Museum, to which the Department was transferred with its collections, from its earlier home in Hastings Street, Calcutta, just before Oldham retired The collections in the Museum were obtained partly by purchase, exchange and gift, and partly by the Survey's officers in the field The Greg collection of meteorites, obtained by purchase, was one of the most notable of these additions to the Museum , with the frequent receipt of the stony meteorites that are seen to fall in India, the Calcutta collection remains one of the best in the world

Passing from the early days of survey, reference must now be made to the remaining seventy-five years of the departmental history H B Medlicott, on succeeding Oldham, proceeded at once to carry out the latter's project for a "Manual of the Geology of India" to summarize the results of the work of this initial period of the Department's work The first two parts of this Manual, written by Medlicott and W T Blanford in collaboration, were published in 1879, with the first authentic geological map of India (first edition issued in 1877) Part 3, on "Economic Geology", by Valentine Ball, was published in 1881, and Part 4 on "Mineralogy" by Mallet, in 1887, who had arranged the mineral collections of the Department and who must be regarded as the 'father' of Indian mineralogy

The results achieved during Oldham's period as superintendent had been achieved without the use of the microscope in the study of rocks, so that no serious studies had been made of the detailed constitution of the metamorphic gneisses and schists of the Peninsula The introduction of the use of the microscope for petrology in India was due to General McMahon, during Medlicott's time During the same period Bruce Foote, working in southern India, distinguished belts of schists from the associated gneisses under the term 'Dharwar'

In 1885 the title of the head of the Department was changed from superintendent to director, and the term superintendent was applied to the officers in charge of the main subdivisions of work under the director Medlicott retired in 1887, and was succeeded in turn by William King (1887–94) and C L Griesbach (1894–1903) Under these two directors work continued on the lines already laid down But on the promotion of T H Holland to be director in succession to Griesbach, new vigour was imparted to the Department The number of personnel was increased, the emoluments of the officers improved, increased importance was given to economic studies, and special memoirs were issued on coal, manganese ore and petroleum Holland also revived the dormant *Records of the Geological Survey of India*, and started the publication therein of reviews of the mineral production of India, both annual and quinquennial In order to encourage investigation where private enterprise lagged, Holland secured a grant for the purpose of drilling on the copper belt of Singhbhum, and the present successful Indian Copper Corporation must be regarded as a lineal successor of the work then undertaken The effect of Sir Thomas Holland's appointment as director can be compared to that of a geological uplift fault, for the Department was raised by him in both public and government esteem to an altitude it had not previously occupied, and from which it has not fallen back

Since Holland's time, successive directors have been Sir Henry Hayden (1910–21), Sir Edwin Pascoe (1921–32), Sir Lewis Fermor (1932–35), Dr A M Heron (1935–39), Sir Cyril Fox (1939–43), Dr E L G Clegg (1943–44) and Dr W D West (1945–)

Hayden's period covered the First World War, at the outbreak of which he encouraged as many officers as possible to join the Armed Forces Eight officers took advantage of this sanction and obtained commissions, and one of the most promising of the young men, R C Burton, lost his life in Mesopotamia Of the others who went on active service to various parts of the world, six were recalled before the end of the War because of the need to promote the production of minerals in India, of which mica and wolfram were the most important , the Department took charge of the production of mica from certain parts of Bihar, and helped to promote the output of wolfram from Tavoy in Burma

Pascoe's period was marked by the institution of a re-survey of Indian coalfields, and also of the Salt Range, the latter for the purpose of settling by mapping revived controversy on the age of the Saline Series Under Pascoe the Department reached the increased strength for which sanction had been obtained by Sir Henry Hayden

My own period as director (which really commenced with Pascoe's departure on leave in 1930) was unfortunate because it coincided with the world-wide depression of 1931–32 and the decision of the Government of India to retrench severely all its scientific services In the end, after much resistance the blow was softened, but nevertheless the departmental strength was reduced by various devices from thirty to twenty graded officers My period was also characterized by the occurrence of several great earthquakes in India and Burma, of which the most disastrous were those of Bihar (January 15, 1934) and Quetta (May 31, 1935), each accompanied by great loss of life Such earthquakes also affect the field-work of the Department, as it is the practice to send officers immediately into the field to study the affected areas

Dr Heron succeeded in retrieving some of the lost posts, a process continued by his successor, Sir Cyril Fox Fox had also to cope with the incidence of the Second World War and the need to stimulate the production of minerals in India, and as a result of these needs he formed a minerals utilization branch of the Department He also found it necessary, partly because of the shortage of paper, to suspend the normal publications of the Department

Dr Clegg died unexpectedly after a very short spell of office, so that to Dr West has fallen the task of the complete reorganization of the Survey in view of the need to recruit a great number of young Indian geologists to provide for a great expansion of departmental activities

During Oldham's time there was no provision in India for geological education, and consequently it was impossible to obtain qualified Indians for the staff Accordingly, Oldham introduced a system of apprenticeship, but this was not a great success The first Indian to be appointed after geological education abroad was P N Bose (1880), followed by P N Dutta (1888), but the Indianization of the Department did not make much progress until the present century, when increasing provision for geological education in India, and increased facilities in the form of scholarships for study abroad, ensured a steady supply of well-trained Indian geologists The position now is that there are only two Europeans left on the graded staff, with a few such officers on short-term agreements for special purposes The training of the numerous young Indian geologists who have been recruited at a great pace recently has proved a problem, partly solved by sending a batch to the University of Melbourne for training, and partly by the institution of geological survey training camps in India

The well-known publications of the Department, namely, the *Memoirs* and the *Records of the Geological Survey of India* and the *Palæontologia Indica*, the latter containing descriptions of the fossils, faunas and floras of India contributed by specialists in the various groups all over the world, were all started by Thomas Oldham There have unfortunately been two breaks in the continuity of the *Records*, the first during Griesbach's directorship, when he apparently found too troublesome the regular issue of this publication, intended to be quarterly, and instead issued a director's annual report The other break was during the Second World War, when paper was difficult to obtain An additional journal, entitled *Indian Minerals*, has been added to the departmental publications since 1947 , this is issued for the purpose of disseminating information on economic problems and is of a semi-popular nature

The first edition of the "Manual of the Geology of India", Parts 1 and 2, by Medlicott and Blanford, was, as already mentioned, issued in 1879, and this work was revised in one volume by R D Oldham (the son of Thomas) in 1893 Sir Edwin Pascoe undertook the preparation of a new edition during his retirement, and a portion of this was in the press and ready for printing off when the Second World War broke out The paper shortage prevented its issue, and eventually the type-metal, being needed for other purposes, was melted down After the War the work had to be reset and modified in view of the number of years that had elapsed But Sir Edwin Pascoe, before his recent untimely death, succeeded in passing the proofs of the first volume, and I understand that this has now been issued, though no copies appear yet to have reached Great Britain We may regard as a preliminary to this latest edition of the Manual the latest (fifth) edition of the "Geological Map of India and Adjacent Countries" on the scale of 1 inch to 32 miles, issued in eight sheets in 1928

Mention must also be made of the most useful of all recent Indian geological publications, T H D La Touche's wonderful "Bibliography of Indian Geology and Physical Geography with an Annotated Index of Minerals of Economic Value", published in four parts during 1917–26

One other important point requires mention, namely, the changes in the geographical scope of the Geological Survey of India Up to 1937 the Department was responsible for the geological survey of both India and Burma, but on April 1, 1937, Burma was separated from India, and the new Burma Geological Department was formed, staffed by officers seconded from India The partition of the Indian Empire on August 15, 1947, necessitated the formation of a Geological Survey of Pakistan, of which Dr H Crookshank, then due shortly to retire from the Indian Survey, became the first director, while Dr W D. West continued as director of the Geological Survey of India

Throughout its history the Geological Survey of India has not, however, restricted its scope to the political boundaries of India and Burma Instead, opportunities have been taken of deputing officers to accompany military and other expeditions, including boundary commissions, so that the Department has contributed largely to our knowledge of the surrounding countries—for example, Blanford in Persia and Abyssinia, Pilgrim in Persia, Mallet in Aden, Griesbach and Hayden in Afghanistan, Stoliczka in Yarkand, Hayden and Heron in Tibet, and Coggin Brown in Yunnan—which explains the words "and Adjacent Countries" in the title of the geological map of India already mentioned

THE STATISTICAL THEORY OF SOLUTIONS

A CONFERENCE on "The Statistical Theory of Solutions" was held in the Department of Chemistry, University of Manchester, during the week-end September 30–October 2 The central topic of discussion was the molecular interpretation of free energies of mixing and the other bulk thermodynamic properties of solutions The interpretation and correlation of these properties is of obvious importance in connexion with phase equilibria, and various speakers showed how statistical theory could be applied to transitions in the solid state, liquid–vapour equilibria in the critical region, and the virial coefficients of mixed gases

The first meeting, at which Prof M. G. Evans presided, was opened by Prof E A Guggenheim (Reading) He began with a historical survey of the theory of regular solutions, as developed by Fowler and his school, and went on to describe some new work being carried out at Reading by Mr. M L. McGlashan Leaving aside the question how well the assumptions of the theory describe real solutions, there are two essentially distinct mathematical methods by which it is possible to calculate the free energy of a quasi-crystalline solution. The first method is to expand the free energy of mixing as a power series in w/kT, where $w = 2w_{AB} - w_{AA} - w_{BB}$, and u_{AB} is the (free) energy of an AB contact ; this method was later discussed in more detail by Dr G S Rushbrooke The second is the combinatory method, or its equivalent, the quasi-chemical method

In this approximation the sites in the pseudo-lattice are considered in pairs, sets of three, or larger groups, and it is assumed that the modes of occupation of these different groups are independent of one another. This assumption will become more accurate the larger the number of sites in a group; and Prof. Guggenheim compared the results of the so-called 'zeroth' approximation with those of the combinatory method applied to pairs, triangles and tetrahedra of sites on a close-packed lattice. The zeroth approximation is surprisingly good, but there should be a definite trend in the calculated free energy as successively larger groups of sites are considered. Mr. McGlashan reported some interesting calculations on the alloy Cu_3Au, where a transition predicted by the zeroth approximation disappears in the first two combinatorial approximations, but reappears when sets of four adjacent sites are considered.

A short account of the method of power series expansion was given by Dr. G. S. Rushbrooke (Oxford). He outlined how it is possible to expand the restrictive grand partition function as a power series in w/kT at high temperatures, or in $\exp(-w/kT)$ at low temperatures. It has not been possible to establish rigorously that either series converges; but numerical computations made by Mr. A. J. Wakefield for the case of equal activities strongly suggest that the regions of convergence of the two expansions meet at the critical mixing temperature, which is given approximately by $w/kT_c = 0{\cdot}45$. It seems that, in the absence of an exact solution to the three-dimensional lattice problem, the method of power series expansion will probably give the most reliable information available as to the free energy of a quasi-crystalline solution.

Prof. Evans then asked whether it was possible to make any useful statement as to the dependence of the parameter w upon temperature or pressure, since this dependence would have an important effect upon the excess entropy or volume of mixing. In reply, Prof. Guggenheim said that w is not to be regarded as an ordinary absolute energy; it is defined in terms of the work required to interchange an interior molecule of liquid A with an interior molecule of liquid B, and can only be obtained statistically by averaging over all accessible states of the remainder of the system, weighting each state with the appropriate exact Boltzmann factor. For this reason w may be described as a 'co-operative free energy', and would be expected to vary with temperature, though not with composition. Prof. Guggenheim stressed the point that for regular solutions the temperature-dependence of w does not affect calculations of the free energy, which are based on strictly isothermal arguments; but it is not possible to calculate entropies and volumes of mixing without additional information as to how w varies with T and p. In the discussion that followed, in which Dr. Rushbrooke and Dr. Longuet-Higgins took part, attention was focused on the difficulty of even writing down the partition function if w is regarded as anything but an absolute energy; allowing w to vary with T makes the theory more elastic, but at the cost of introducing further uncertainties.

At the second session Dr. H. C. Longuet-Higgins (Manchester) described an alternative approach to the theory of solutions. Theories of solution are generally based on some definite or indefinite model of the liquid state, such as the Lennard-Jones cell model or the quasi-crystalline model, and it is difficult to be certain that such a model is statistically consistent with any particular assumptions about the intermolecular forces. However, it is possible to find a set of reasonable assumptions about these forces which enables one to calculate the thermodynamic properties of mixing without appealing to any model at all. It is assumed that, for every pair of molecular species r and s in the solution, the intermolecular energy u_{rs} as a function of distance ρ is given by the equation $u_{rs}(\rho) = f_{rs}u_{00}(g_{rs}\rho)$, where $u_{00}(\rho)$ is the intermolecular energy function of some chosen component, and f_{rs} and g_{rs} are constants close to unity. A system satisfying these assumptions may be called a 'conformal solution', and it can be proved that for a binary conformal solution the excess free energy of mixing at constant T and p is given by the equation

$$\Delta^*G = E_0(2f_{12}-f_{11}-f_{22})x_1x_2,$$

plus terms of the second order in $(f_{rs}-1)$ and $(g_{rs}-1)$, where E_0 is the intermolecular energy of the chosen component, and x_1 and x_2 are mole fractions. Now E_0 is an observable quantity, the variation of which with temperature and pressure can be measured experimentally; so it is possible to correlate the excess free energy, entropy and volume of a conformal solution in terms of the experimental properties of the components; and these predicted correlations are in good agreement with available data on non-polar solutions. It is interesting to note that, even though the molecular distribution in a conformal solution is random in first approximation, there may nevertheless be a first-order excess entropy of mixing, connected with the temperature variation of E_0. The succeeding discussion, in which Mr. R. P. Bell (Oxford) and Prof. Guggenheim took part, returned to the interpretation of entropies of mixing; and it became clear that non-ideal entropies of mixing are not necessarily to be understood in terms of order and disorder.

The next speaker, Mr. D. Cook (Manchester), described the quantitative application of conformal solution theory to phase equilibria in the critical region and, in particular, to the system ethylene carbon dioxide, recently studied experimentally at the Imperial College of Science and Technology, London, by Mr. S. M. Shah and Prof. D. M. Newitt. In order to calculate the T, p, x curves for the two-phase region, it is necessary to calculate E_0 from the equation of state of, say, carbon dioxide; this can be done by extrapolating the available p, V, T data to the requisite low temperatures, but it introduces an unavoidable uncertainty into the theoretical results. Nevertheless, using a value of $2f_{12}-f_{11}-f_{22}$ derived from the observed critical-temperature curve, one can calculate with considerable accuracy the compositions of phases in equilibrium at a given temperature and pressure; and, in particular, the theory predicts the observed azeotropy in this system, and the direction in which the azeotropic composition varies with temperature.

Mr. McGlashan and Prof. Guggenheim then explained a method of calculating the second virial coefficients of gaseous mixtures from the virial coefficients of the pure components known as functions of temperature. This method is based on similar assumptions to those of conformal solution theory, except that it is not necessary to assume that the interaction constants f_{rs}, etc., are all close to unity. The results agree much more closely with experiment than do those of any previous theory, and details will soon be published elsewhere. It seems, therefore, that we are obtaining a better understanding of gas mixtures, and solutions other than those for which the regular assembly is a satisfactory model

At the third session Prof I Prigogine (Brussels) described some recent work extending the Lennard-Jones and Devonshire model of liquids to binary mixtures at temperatures far from the critical point In such systems it is possible to study the way in which the effective vibration frequency of a molecule in its 'cell' changes with concentration, and also how the mean size of the cells changes with concentration It is found that both these effects have an influence on the thermodynamic functions, and give important corrections to the usual approximation of regular solutions The magnitude of these effects has been calculated for the system carbon tetrachloride–carbon tetramethyl, and preliminary measurements give results in good agreement with the theory Prof Prigogine also reported some theoretical calculations in which account is taken of the presence in a liquid of Lennard-Jones cells containing 0 or 2 molecules Such calculations lead to a much better value for the critical volume of a liquid , but, as yet, the work has not been extended to systems of more than one component Other topics which arose in the succeeding discussion included the surface tensions of solutions composed of molecules of unequal size or shape , the variation of surface tension with composition gives a sensitive indication of the way in which molecules are oriented in a surface and supplements the information that can be obtained from the bulk thermodynamic properties

The last session of the conference was devoted principally to the present experimental position In his introductory paper Prof D H Everett (Dundee) mentioned the scarcity of accurate data on the thermodynamic properties of solutions, and stressed the importance of choosing suitable experimental systems for the testing of particular statistical theories Older work was concerned primarily with solutions departing little from ideality, but more recently both experimental and theoretical work has been concerned with departures from ideality due to flexibility and differences in shape Prof Everett discussed in some detail the system benzene–diphenyl, recently studied with concordant results by several different workers As he pointed out, the results cannot be quantitatively interpreted in terms of a quasi-crystalline model with benzene occupying one site and diphenyl two , it seems that in dilute solution diphenyl must disorient the benzene structure, and perhaps for this reason the system is not a satisfactory one against which to test the theory Prof Everett directed attention to the useful supplementary information that may be derived from measuring non-thermodynamic properties such as viscosity, dielectric constant and absorption spectra In the critical region very few reliable thermodynamic data are available , and here a few well-chosen measurements should greatly increase our understanding of such phenomena as the solubility of solids in vapours

In the discussion, Mr J H Baxendale gave a careful analysis of the experimental errors in his investigation with Dr B. V Enustin of the benzene–diphenyl system, and showed that the discrepancies with the simple theory are well outside the experimental errors Dr V Mathot (Brussels) described a method of calculating the thermodynamic properties of a solution in which the solute consists of monomers and associated complexes The activity coefficient of carbon tetrachloride in mixtures of this liquid with alcohols is found to fall between the value calculated from the Flory–Huggins model and the value appropriate to an 'ideal infinitely associated' solution Further, it can be shown by the principle of detailed balancing that the ratio of activity coefficients of solute and solvent is equal to the fraction of solute molecules in the monomeric state , and this relationship is verified with great accuracy by spectroscopic measurements on the hydroxyl vibrational absorption band in its first and second overtones This shows clearly that deviations from ideality are, indeed, due to the formation of complexes in these systems Another observation which aroused great interest was the fact, reported by Dr J H van der Waals (London), that the heats of mixing of hydrocarbons sometimes vary considerably with temperature , no satisfactory explanation has yet been found for this phenomenon

Among the visitors who also took part in the conference were Dr F Booth (King's College, London), Mr J L Copp and Mr G Duff (Dundee), Dr M J S Dewar and Dr H Tompa (Maidenhead), Dr R Freeman and Dr W Moffitt (Welwyn), Dr E. L Mackor (Oxford), Dr P Meares (Aberdeen), Dr G J Szasz (American Embassy, London), Mr Trappeniers (Brussels) and Dr. L R G Treloar (Royal Institution, London)

H C Longuet-Higgins

OBITUARIES

Dr L J Comrie, F.R S.

Dr Leslie John Comrie died on December 11 at his home in London at the age of fifty-seven His health had been failing after a stroke two years ago, which left him with an active mind, but with much reduced capacity for work He worked right up to the last, almost completing a project of long standing—a guide to errors in published mathematical tables

Comrie was born at Pukekohe, New Zealand He took a degree in chemistry at Auckland University College, before joining the New Zealand Expeditionary Force and serving in the First World War, during which he lost a leg After the War he gave up chemistry for astronomy and computation, which were to be the great interests of his life He was elected an Isaac Newton Student at Cambridge, and took his Ph D in 1923 He then spent three years in the United States, teaching astronomy and introducing computation into the student courses, first at Swarthmore College, then at North-Western University, Evanston, Illinois

Returning to England, which he made his home, he served the Nautical Almanac Office first as deputy superintendent, then, during 1930–36, as superintendent During this period he revolutionized the "Nautical Almanac" and its computation By mechanizing calculation he greatly increased its range, accuracy and cheapness This was reflected in great changes in the content of the "Nautical Almanac" itself—the major ones came first in that for 1931—which much increased its value as an astronomical tool

In 1937 Comrie left the Nautical Almanac Office to found the Scientific Computing Service, Ltd , the first independent professional organization (and still the only one) to provide large-scale computation with high mathematical content This organization, under his directorship, has performed major computational work in many fields—for industry, for government departments and for universities Emphasis was on accuracy, and on the lack both of dislike and of fear of computation—no job was ever turned down as being too large When the Second World War broke out, one of Comrie's most valuable contributions consisted of two volumes of 200 pages of double-entry ballistic tables for the War Office, which were designed, computed, proof-read, printed and bound under his direction within the first twelve days of the War.

Comrie's main work was in the application of commercial machines to computational problems and in the construction of mathematical tables He was opposed to the building of special calculating machines, but advocated always an examination of existing machines, available in considerable numbers, to see which was best adapted to the problem in hand He was adept in devising special methods by which such machines could best be used, and in modifying the computational formulæ to fit the machines He was never reluctant to tell a client that he was asking for unnecessary accuracy or results, or to point out that proposed methods were wrong or unduly lengthy.

One of his most constant objectives was the complete replacement of logarithmic computation by machine computation , he was always advocating the widespread adoption of calculating machines in all business and research establishments, and was always ready to advise on the choice of machine for each job to be tackled It was his belief that, eventually, everyone who had need to compute should and would have a calculating machine. His experiences and judgment in this respect were acknowledged by the leading manufacturers and distributors of calculating machines, who could always be sure of advice based strictly on the merits of the machine and problem under discussion

Comrie's work in preparing mathematical tables will probably form his most lasting memorial At the Nautical Almanac Office and in collaboration with Prof J Peters of Berlin, he was interested in preparing tables of trigonometrical functions in exactly the form needed to help the computer most, and prepared several tables giving natural values to meet the needs of mechanical computation, for which logarithmic values are useless

As secretary of the British Association Mathematical Tables Committee, he played a leading part in the preparation of most of the B A. Mathematical Tables—achieving standards of typography and accuracy not previously considered attainable

The "Standard Four-figure Mathematical Tables", prepared with Prof L M Milne-Thomson, and his two revisions of Barlow's Tables are well known So also are his last works to appear during his life-time, namely, his revision of "Chambers's Mathematical Tables" ; the four-figure tables contain more useful tables, formulæ and ideas about tables and computing than have ever before been collected into 64 pages, while in the two volumes of "Chambers's Six-figure Mathematical Tables" he has prepared a set of tables replacing the old seven-figure tables, which should meet nearly all needs in the elementary field for many decades to come In the introductions to these two volumes he has compressed an account of a very large proportion of his computational experience—they may almost be used as a text-book on general computational techniques He was the first to believe that the maker of tables not only should, but also could, provide tables that were free from error He believed, too, that it was his duty to give the user every possible aid and convenience Comrie had an almost professional knowledge of typography, and the careful and expert attention which he always paid to this art, as well as to the logical austerities of the English language, set its mark on all his work

Besides a great interest in the preparation of mathematical tables, Comrie had an equally powerful interest in other tables, and he conducted systematic and thorough searches for errors over very many years His experience in these matters was very great, and it is fortunate that he had almost completed a record of this experience This is to appear as part of a new edition of "An Index of Mathematical Tables", prepared by Fletcher, Miller and Rosenhead The first edition of this "Index" was actively sponsored by Comrie, who financed publication through the Scientific Computing Service

Comrie's outstanding contributions to the field he had done so much to extend and transform were acknowledged by election to the fellowship of the Royal Society last March He was the first in this field to receive such recognition

His experience and enthusiasm in computation and table-making will be very greatly missed He will also be missed by his many astronomical and New Zealand friends, who could always be sure of interest, encouragement and help J C P Miller

Prof. J W. Cobb, C B E

On Saturday, November 25, John William Cobb died in Leeds at the age of seventy-seven Educated at the Leeds Modern School, he entered the Yorkshire College (now the University of Leeds) in 1889 After graduating in the University of London at the age of nineteen, he went straight into industry with the Farnley Iron Co , Ltd , of Leeds This firm manufactured certain high-grade local products—wrought iron and clay ware John Cobb found himself in a works peopled with skilled craftsmen but without a scientific atmosphere He was commissioned to learn by his own observation and experiment, but without a laboratory His employers were in advance of the times and not lacking in encouragement. Thus he was able to advance the technique of the works, especially in the efficient use of fuel In this way he acquired a reputation for knowledge of industrial gas heating Endowed with curiosity and initiative, and thanks to the support of his employers, Cobb was able to carry out a considerable amount of investigation of works processes, notably on the solid reactions of silicates In this, he showed himself ahead of his contemporaries

In 1904 the Yorkshire College attained university rank and one of its first acts was to embark on the study of, and research on, fuels This enterprise was the first of its kind in a British university In 1906, a Department of Fuel and Metallurgy was established under the responsibility of Prof W. A Bone He retained this position until 1912, when he took office in the new Department of Fuel at the Imperial College of Science and Technology

In the meantime, the Fuel Department at Leeds had become associated with the science and technology of towns' gas In 1910, when, by death, the British gas industry had lost one of its leading members, Sir George Livesey, it chose to use its resources to endow the chair of the new Department in Leeds. The departure of Prof Bone to London called for the appointment of a successor. Actually, no better choice could have been found than John W Cobb Appointed thus in 1912, he continued in office until 1938 In two years, however, the First World War broke out, followed by unforeseen problems The Fuel Department at Leeds, the only one of its kind, had associations with the British gas industry, and the industry was faced with urgent technical problems arising from the War. To meet these needs, it was found necessary to establish a joint research organization between the University and the gas industry This organization proved successful and led to extension and imitation There is no doubt that the early success of these efforts owed much to Prof Cobb's capacity and judgment.

H J. Hodsman

Mr. C E. C Fischer

The death occurred on October 19, at the age of seventy-six, of Cecil Ernest Claude Fischer, formerly of the Indian Forest Service

Born in Bombay on July 9, 1874, Fischer first went to school in Neuchâtel, Switzerland, and later to private schools in Brighton and Stratford-on-Avon In 1892 he entered Coopers Hill College, Englefield Green, where he received his forestry training He passed out of the College in September 1895 to join the Indian Forest Service in the Madras Presidency From 1907 he acted as forest entomologist at the Forest Research Institute, Dehra Dun. During 1908–9 he was on furlough, taking special leave to study plant pathology in Munich and London During the years 1915–17 he was principal of the Madras Forest College He assisted the professor of forestry for four university terms at the School of Forestry, Oxford, during 1919–20 After his return to India in 1920, he became a conservator of forests, Madras, which post he held until he left at the end of 1923, finally retiring from the Indian Forest Service in 1926

Retirement did not mean, however, a life of leisure for Fischer, but merely the dropping of his official duties in the Indian Forest Service and the commencement of a period of very useful work at Kew In 1925 he was appointed assistant for India in the Herbarium of the Royal Botanic Gardens, where he remained until he reached the age limit in 1940. While at Kew he brought to a conclusion the late J S. Gamble's "Flora of the Presidency of Madras", being responsible for the third volume of this work, from Ulmaceæ to the Gramineæ Following Gamble's practice, he published explanatory notes during the progress of the "Flora" in the *Kew Bulletin.* He also published a number of other papers in the *Kew Bulletin*, including his important "Contributions to the Flora of Burma" (1926–40), "Plants New to Assam" (1929–40), "New or Little Known Plants from South India" (1932–39), and his determinations of "The Koenig Collection in the Lund Herbarium" (1932) His valuable "Survey of the Flora of the Animalai Hills" (1921) and "Flora of the Lushai Hills" (1938) appeared in the *Records of the Botanical Survey of India* He described many new species, and in naming one of these he commemorated the Indian Forest Service

Fischer had a strong sense of civic duty and served on many committees During the War he was an air-raid warden, and while on duty in an air raid was injured and left permanently slightly lame. After the War he taught himself to make Braille books for the blind and became very proficient at this self-imposed task

No one who knew Fischer could fail to appreciate his sterling integrity of character and the pleasant manner in which he discharged his manifold duties.

H. S Marshall

We regret to announce the following deaths

Prof E Abderhalden, editor of the well-known "Handbuch der biologischen Arbeitsmethoden", on August 5, aged seventy-four.

Sir Leonard Parsons, F R S, emeritus professor of pædiatrics and child health in the University of Birmingham, on December 17, aged seventy-one

NEWS and VIEWS

New Year Honours

The following names of scientific men and others associated with scientific work appear in the New Year Honours list

K.B E Mr Harry Mason Garner, chief scientist, Ministry of Supply, Dr Arthur Elijah Trueman chairman, University Grants Committee

Knights Dr Frank Macfarlane Burnet, director of the Walter and Eliza Hall Institute for Medical Research, Melbourne, for services to biological research, Mr Thomas Dalling, chief veterinary officer, Ministry of Agriculture and Fisheries, Prof Thomas Henry Havelock, emeritus professor of mathematics, King's College, Newcastle upon Tyne, Mr Christopher Hinton, deputy controller of Atomic Energy (Production), Ministry of Supply, Dr Gordon Morgan Holmes, consulting physician, Charing Cross Hospital and National Hospital for Nervous Diseases, Mr Henry Thirkill, master of Clare College, Cambridge, and chairman of the Cambridge University Joint Recruiting Board.

C B Mr E Barnard, deputy secretary, Department of Scientific and Industrial Research, Mr W R J Cook, chief of the Royal Naval Scientific Service, Admiralty, Dr W F P McLintock, lately director of the Geological Survey and Museum

C M G · Mr W Abbott, H M inspector of schools, Ministry of Education, Dr W J Hall, director of the Commonwealth Institute of Entomology, Dr C F Hickling, fisheries adviser to the Secretary of State for the Colonies, Mr J C Muir, Colonial Agricultural Service, member for agriculture and natural resources, Tanganyika, Mr H J Page, principal of the Imperial College of Tropical Agriculture, Trinidad, Dr G L Sutton, for services to agriculture in Western Australia

C B E . Mr K Baumann, for services to turbine development, Mr H J Braunholtz, keeper of the Department of Ethnography, British Museum, Mr S E Chisholm, assistant controller, Patent Office, Mr Hayne Constant, director of the National Gas Turbine Establishment, Ministry of Supply, Dr Oscar Faber, for services in the rebuilding of the

House of Commons, Dr A H R. Goldie, deputy director (research), Meteorological Office, Air Ministry, Mr W H Guillebaud, deputy director-general, Forestry Commission, Mr W L M O'Connor, director of carbonization, National Coal Board, Mr J E Serby, deputy director, Royal Aircraft Establishment, Farnborough; Prof A N Shimmin, professor of social science in the University of Leeds, for services as a member of the National Arbitration Tribunal, Dr S L Smith, director of research, British Shipbuilding Research Association, Dr V B Wigglesworth, director of the Unit of Insect Physiology, Agricultural Research Council, Mr R Yates, deputy chief inspector of mines, Ministry of Fuel and Power

Astronomical Observatories at Mount Stromlo, Australia

For some years the Yale and Columbia Universities have jointly operated a Southern Station at Johannesburg, but they have recently become embarrassed by the deterioration of astronomical observing conditions in that city, due to its industrial development It became necessary to seek a site in some country locality, and the two American Universities have accepted an offer made by the Australian Government to set up the Station on Mount Stromlo next to the Commonwealth Observatory It is now planned to move the principal telescope, which is a refractor of 26 in aperture and 400 in focal length, late in 1951, and to erect a wide-field camera of 8 in. aperture and 80 in focal length at about the same time. The station will be under the charge of Mr Cyril Jackson, who will carry out programmes as arranged by the directors of Yale and Columbia Observatories, Dr Dirk Brouwer (who visited Mount Stromlo in November and December) and Jan Schilt It is expected, however, that there will be some interchange of observing time with the Commonwealth Observatory

It is proposed to continue photographic determinations of stellar parallax, proper motions, mass ratios of binary stars and of the positions of minor planets, and photo-electric determinations of stellar magnitude Provision of a visual correcting lens and of an objective prism for the long-focus refractor is under consideration. This telescope will complement the 74-in reflecting telescope now being constructed for Mount Stromlo by Messrs Sir Howard Grubb, Parsons and Co, and the old Melbourne 48-in telescope which is being re-erected on Mount Stromlo as a Schmidt camera, and it is hoped that co-operation between the Yale–Columbia observers and those of the proposed Swedish observatory on Mount Stromlo with the staff of the Commonwealth Observatory and of the Australian National University will prove fruitful of astronomical results

Medical Aspects of Atomic Warfare

The real danger that atomic warfare may be employed in a further world conflict makes the symposium on its medical aspects, organized by *The Practitioner* with the advice of Sir Ernest Rock Carling, and published in its December issue, specially timely Its aim is to provide essential information on the hazards of atom bomb explosions Ten articles, written by experts, cover very briefly the physical, biological, genetical and medical aspects. The contributors to the symposium have taken advantage of the various official publications and personal reports concerned with the atomic explosions at Hiroshima and Nagasaki One of the papers deals with the assessment of possible casualties and damage which might be caused by an atom bomb bursting over a British city, and contains many thought-provoking if unpleasant data A proper distinction is drawn between gross pathological lesions, which are well summarized, and the deleterious genetical effects manifesting themselves only in later generations and the distant future The information given in these ten articles, though chiefly directed to the medical profession, will undoubtedly be useful to all concerned with our defence and safety. In an editorial comment it is suggested that medical men in possession of such knowledge will be able "to calm the fears of our more apprehensive patients", and keep up the morale of the population, we must, however, remain of the opinion and hope that if this information concerning the consequences of an atom bomb attack is shared by an adequate number of the potential "patients" themselves, the ghastly prospect may yet become sufficiently remote

Catalogue of Economic and Social Projects of the United Nations

The "Catalogue of Economic and Social Projects, 1950" (pp 515, Lake Success, N Y United Nations, London: H M Stationery Office, 1950, 3 75 dollars or 27*s* 6*d*), issued by the United Nations secretariat at the request of the Economic and Social Council, lists, describes and classifies the work during 1949 of the secretariats of the United Nations and of the Specialized Agencies in the economic and social fields The main bulk of the information, which includes research studies and investigations as well as technical services and other operational activities, is set forth under the different departments responsible, first of the United Nations and then of the Specialized Agencies, but the analytical index which constitutes Part 2 of the Catalogue brings together, under headings representing the main sectors of the economic and social field, the work of the United Nations and the Agencies related to each sector The subject headings, adopted for this classification as a result of consultation among the Agencies and the United Nations, represent a compromise and are regarded as experimental There is some repetition, but they do assist in giving a fairly coherent picture of the work going on in particular fields, though no complete picture is given of what is taking place in science or in any one branch of science Although the Catalogue is not primarily a bibliography, much bibliographical information on reports and other published documents is included Not the least useful features are the two lists appended, giving the libraries where documents of the United Nations and of the Specialized Agencies can be consulted, and U N information centres and the sales depots where documents of the Specialized Agencies are available

Nuffield Foundation Awards for Biology and the Social Sciences

As an experiment during the next three years, the Nuffield Foundation is offering annually a small number of scholarships and bursaries in biology and in the social sciences (excluding economics) for British graduates of about 22–35 years of age, which will be tenable initially for one year but renewable up to three years The awards in biology are for persons who have graduated in the physical sciences or in mathematics and who wish to pursue a course of further training in biology The scholarships are for those with some previous postgraduate experience and are worth £500–600 with additional allowances of £50 if married and £50 for each of the first two children, together with travelling expenses, etc , where applicable The bursaries are for those who have recently graduated and are worth £350, with the allowances already quoted. The awards for the social sciences are the same as those for biology except that the holder may have a degree in any subject other than the social sciences, though one in natural science is preferable Application forms, to be completed by May 1, can be obtained from the secretary of the Nuffield Foundation, 12–13 Mecklenburgh Square, London, W C 1

University of London

THE following announcements have been made by the University of London Dr F. M Haines, reader in botany at Queen Mary College, has been appointed to the University chair of botany tenable at the College The title of professor of papyrology in the University has been conferred on Mr E G Turner in respect of the post held by him at University College The following doctorates have been conferred *D Lit.* . Prof L. Dudley Stamp (London School of Economics) , *D Sc :* Mr S. J. Y Edwards (Royal Veterinary College) , Miss A M. Robinson (Bedford College and University College)

University of St. Andrews

THE following appointments in the University of St Andrews have been announced. Dr. W L. Burgess, reader in public health, to the new James Mackenzie chair of public health and social medicine , Dr E F Freundlich, Napier lecturer in astronomy, to the new Napier chair of astronomy.

Exhibition of Recent French Scientific and Technical Publications

A SMALL collection of recent French publications in different branches of science and technology, arranged by the Cultural Relations Department of the French Foreign Office with the assistance of the French Publishers' Association, is being shown in Great Britain during the coming months The exhibition will be at the Science Library, Imperial Institute Road, London, during January 13–23 inclusive , at the Radcliffe Science Library, Oxford, during January 29–February 6 , in the Great Hall of the University of Birmingham during February 13–20 , at the Mitchell Library, Glasgow, during March 12–20 , and at the Central Library, Sheffield, during April 30–May 12 Admission will in all cases be free and without ticket The exhibition will be inaugurated on January 12 at 6 15 p m in the Science Library, when short addresses will be given by Dr F Sherwood Taylor, director of the Science Museum, and Mr J D Newth, president of the Publishers' Association of Great Britain

The Night Sky in January

NEW moon occurs on Jan 7d 20h. 10m , U T., and full moon on Jan 23d 04h. 47m The following conjunctions with the moon take place Jan 10d 02h , Mars 2° N , Jan 11d 08h , Jupiter 0 2° N , Jan 27d 23h , Saturn 4° N Mercury, in inferior conjunction on January 1, rises at 6h 30m and 6h. 40m on January 15 and 31 respectively, and can be seen in the eastern sky for a short time , but the planet has a large southern declination and will not be a conspicuous object in the British Isles Venus sets three-quarters of an hour after the sun on January 1 and an hour and a half after on January 31, and is visible in the western sky, stellar magnitude −3 4, practically all the luminous disk being visible Mars sets at 18h 45m , 18h 55m and 19h 05m on January 1, 15 and 31 respectively In the early part of the month the planet is close to θ Capricorni, and about the middle of the month it moves into the constellation of Aquarius Jupiter sets at 20h 55m , 20h 10m and 19h 30m on January 1, 15 and 31 respectively, and can be seen a little east of Mars. Saturn rises at 23h 30m , 22h 30m. and 21h 25m at the beginning, middle and end of the month respectively, and is close to η Virginis during this time Occultations of stars brighter than magnitude 6 are as follows Jan 2d 5h 23 9m , ι Virg (*R*), Jan. 17d 22h 28 5m , 16 Taur (*D*) , Jan 17d 22h 37 4m , 17 Taur (*D*) , Jan 17d 22h 56 2m , *q* Taur (*D*) , Jan 17d 23h 07 2m , 20 Taur. (*D*) , Jan 17d 23h 31 5m , 21 Taur. (*D*) , Jan 26d 23h 09 9m , τ Leon (*R*) , Jan 29d 02h 08 8m , 49 Virg (*R*) *R* and *D* refer to reappearance and disappearance respectively, and Greenwich is assumed as the place of observation The earth reached perihelion on January 2

Announcements

A COURSE of ten lectures under the title "An Introduction to the Science of Nuclear Power" is to be given in the Electrical Engineering Department of the Imperial College of Science and Technology on Fridays at 4 p m , commencing January 12, the lecturers being Dr O Buneman, J Diamond and R V Moore, of the Atomic Energy Research Establishment Applications for admission should be addressed to the Deputy Registrar, City and Guilds College, Exhibition Road, S.W 7

THE symposium on "High-Temperature Steels and Alloys for Gas Turbines" arranged by the Iron and Steel Institute, and the Hatfield Memorial Lecture of the Institute to be delivered by Sir Frank Whittle, postponed from October 17–19 of last year, will take place during February 20–22 Sir Frank Whittle will give his lecture at the Caxton Hall, London, S W 1, on February 20 at 8 30 p m , the symposium will be at the Institution of Civil Engineers, Great George Street, London, S W 1, during the succeeding two days

A COLLOQUIUM on the "Chemotherapy of Tuberculosis" will be held in Dublin during July 10–13 The lecturers will include Dr V C Barry (Medical Research Council of Ireland), Dr Marc Daniels (Medical Research Council, London), Prof G Domagk (Wuppertal–Elberfeld), Dr W H Feldman (Mayo Foundation), Dr P D'Arcy Hart (Medical Research Council, London), Mr T J D Lane (Meath Hospital, Dublin) and Dr Edgar Lederer (Institut de Biologie Physico-Chimique, Paris) Further information can be obtained from J. G Belton, honorary secretary of the organizing committee, at the Laboratories, Medical Research Council of Ireland, Trinity College, Dublin

As from January 1 the six sections, *A* to *F*, of the *Canadian Journal of Research* are being published as separate journals The present title will cease to be used, and the new titles of the separate journals are *Canadian Journal of* [respectively] *Physics, Chemistry, Botany, Zoology, Medical Sciences* and *Technology* The present sequence of volume numbers is retained, the 1951 issues being numbered Vol 29 The subscription-rates are unaltered.

EVOLUTION OF THE AFRICAN CICHLID FISHES: THE *HAPLOCHROMIS* SPECIES-FLOCK IN LAKE VICTORIA

By P. H. GREENWOOD

REGAN[1] concluded that the primary evolution of the endemic species of *Haplochromis* in Lake Victoria had involved adaptive radiation towards different types of food and feeding methods. He further stressed that the basic stock from which they had evolved is represented to-day by *Haplochromis cinereus* Boulenger. Subsequent work has provided a clearer picture of the ecology[2,3] and geological history of the lake which, together with the impression gained from a revision of the Victoria species of *Haplochromis*, has enabled me tentatively to formulate a more detailed outline of the evolution of these fishes.

In Lake Victoria the genus is represented by about sixty species, which may be referred to the following three morphological groups, indicating three peaks of ecological adaptation. Within each group further micro-adaptation may be observed, especially in the first and the third.

Group 1 ('*Cinereus* Group'—twenty-four species). Mouth horizontal, jaws equal, outer teeth bicuspid even in the adult, snout short in relation to the eye, body deep. Ecologically a bottom-feeding inshore complex, regarded as the modern representatives of the stock from which the second and later the third groups were evolved.

Group 2 ('*Guiarti* Group'—seventeen species). Mouth slightly oblique, lower jaw prognathous, dentition variable but conical and caniniform, outer teeth predominating, snout longer than in Group 1, body more slender. Shows affinities both with the preceding and with Group 3. Predaceous piscivorous species, inhabiting the middle depths of open and inshore waters.

Group 3 ('*Acutirostris* Group'—eighteen species). Mouth very oblique and in two species almost vertical, lower jaws strongly prognathous, outer teeth caniniform, snout long, body slender. Clearly derived from Group 2. Predaceous surface-feeding species, mainly insectivorous and piscivorous.

The evolution of these three species-complexes appears to have been intimately connected with the climatic fluctuations and tectonic movements which affected the Central African plateau from Miocene to late Pleistocene times.

The Miocene lake ("Lake Karunga" of Wayland[4]) resulted from the flooding and interconnexion of swamps lying in the depression formed by early Tertiary tectonic activity. The Cichlidæ of this lake are known only from fragmentary fossil remains obtained at Rusinga Island. Generic diagnosis of these has so far proved impossible, but they represent a small generalized form which may possibly be related to *Tilapia nilotica*. During the Miocene, Lake Karunga seems to have risen quite considerably and encroached upon the swampy ground lying to the west[4]. Work now in progress shows that the genera *Lates* and *Polypterus* were present in this lake, the fauna of which was probably destroyed during a period of aridity at the close of the Miocene. Neither of these genera is represented in the present lake, and it is concluded that the fish fauna of Lake Karunga was completely destroyed. During the Pliocene the east–west river systems must have started flowing again, filling the swamps lying in the basin of the future Lake Victoria[4]. Recolonization of these swamps was, perhaps, from the eastern rivers, for example, the proto-Tana and Athi River systems. Evidence for this is derived from the presence of *Tilapia nigra* (a species at present confined to the Athi River) in Pleistocene deposits at Rawe[16]. The fact that *Lates* and *Polypterus* are to-day absent from the eastern rivers as well as from the lake, although they occur in the Nile and the western river systems, may be negative evidence pointing to the same conclusion. Throughout the Pliocene the embryo lake, responding to changes in climate and physiography, alternated between a series of more or less disconnected swamps and a much-branched sheet of water.

Conditions provided by the developing lake would allow for the evolution of *Haplochromis* Groups 1 and 2, Group 1 during the Pliocene and Group 2 during the later Pliocene and early Pleistocene. Small populations of fishes would have been isolated in the swamps, while the gradual filling of the lake basin would allow for migration between previously isolated areas, as well as providing new ecological niches for occupation. Group 1 appears to have evolved during the Mio-Pliocene phases of lake development when conditions were predominantly of the swamp or shallow-lake type. When the lake began to fill during the First Pluvial, a suitable habitat for Group 2 came into being. Here again, division of the lake into several distinct areas of fairly deep water provided the spatial isolation and re-directed selection-pressure necessary for the initiation of evolutionary processes. It seems unlikely that Group 3 could yet have evolved since it is absent from the present fauna of Lake Edward (see below).

From the evidence of the Cichlidæ in Lake Edward[5], we may conclude that the Lower Pleistocene species-flocks of Lake Victoria were represented by a highly evolved Group 1 and more generalized Group 2 complex. During the First Pluvial (Lower Pleistocene), Lake Edward, then continuous with Lake Albert, was connected to Lake Victoria through swamps and streams extending over the area now occupied by the Kagera River valley[6,7,8], with consequent dispersal of the Victoria fishes. The connexion was effected by the drowning of the Ankole river valleys, with subsequent river reversals due both to tectonic activity and the rising level of Lake Victoria.

With five exceptions, all the *Haplochromis* species of Lake Edward are endemic. Dr E. Trewavas (personal communication) favours the consideration of some, at least, as sub-species of the Lake Victoria forms to which they are so closely related. Only two species belong to Group 2, the remainder being of Group 1 and including some of the highly specialized algal and mollusc feeders.

From the similarity of the two populations, I conclude that by the Lower Pleistocene the Group 1 *Haplochromis* in Lake Victoria had reached a state in their evolution comparable with that of the present population. It is not possible to draw such conclusions for Group 2, since it is represented in Lake Edward by only two species of the generalized type.

With the beginning of the Middle Pleistocene there was a period of considerable aridity, the First Inter-Pluvial, during which the continuity of Lakes Albert and Edward was lost, and presumably also that of Lakes Edward and Victoria Worthington[9] (based on Wayland) concluded that Lake Victoria was reduced to a few pools capable of supporting very little life and that, when the lake was refilled by the increased rainfall of the Second Pluvial (Post-Middle Pleistocene), the present fauna was derived from the neighbouring drainage-systems and a few endemic survivors While not denying the relatively severe aridity of that period (see Solomon[8] and Moreau[10] the latter considers that the rainfall was a little less than at present), I do not consider that the lake dried out completely The existence of the Victoria–Edward species complex seems to favour this assumption Rather I believe that, during the Inter-Pluvial, Lake Victoria was reduced to a smaller central body flanked by swampy pools and rivers—that is, a repetition of Pliocene conditions and consequently a period of further evolutionary potentiality

This Inter-Pluvial was succeeded by a second Pluvial, though of less intensity than the first As a result, Lake Victoria was refilled and there was a return to the open-water conditions that prevailed during the lower Middle Pleistocene[12].

With the restoration of these open-water conditions the ecological zone peculiar to the extant species of Group 3 became available for colonization, and it is to this period that I attribute its evolution. Species of Group 2 that survived the adverse conditions of the Inter-Pluvial and retained their evolutionary plasticity seem to have supplied the stock from which Group 3 evolved

The early isolation necessary for its evolution was probably due primarily to intrinsic factors rather than the extrinsic spatial factor responsible for the evolution of Groups 1 and 2 Until more is known of the ecology and ethology of Group 3, the postulated isolating factors of specialized feeding and breeding habits[13] must remain highly conjectural

After the Second Pluvial there appear to have been two Post-Pluvial wet phases[11,12] which did not affect the lake to any appreciable degree, and therefore had little effect upon the major evolutionary trends exhibited by the three groups

The African Cichlidæ have previously been considered as examples of sympatric speciation[9] Mayr[14] questioned this concept and postulated multiple invasion to account for the species-flocks This process may have played a part in the early evolution of Group 1, as at that time Lake Karunga lay in the drainage basin of several Kenya rivers which crossed the area on their way to join the Congo river-system Later evolution, taking place under the conditions outlined above, would be of the usual allopatric type Brooks[15] suggests that the principle of allopatric speciation is applicable to all the species-flocks characterizing 'ancient lakes'. Also he has shown that ecological differences in Lake Nyasa, correlated with specialized feeding-habits, would provide the necessary spatial isolation to account for the Cichlid flocks of that lake

Worthington[9] and Brooks[15] consider that the major evolution of Lake Victoria's Cichlidæ has taken place since the Second Pluvial For the reason outlined above, I would consider the evolution of the flocks to be divisible into two major periods, namely, first, Pliocene to early Middle Pleistocene, and secondly, Post-Middle Pleistocene to Upper Pleistocene To the first division belongs the evolution of the majority of Group 1 and the more generalized species of Group 2, while the evolution of Group 3 and the more specialized members of Groups 1 and 2 may be referred to the second division

I wish to express my gratitude to the Trustees of the British Museum (Natural History) for the facilities provided while working in the Department of Zoology as a Colonial Office fisheries research student, and to Dr E. Trewavas and Mr D W. Tucker for their assistance and encouragement

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INFORMATION THEORY

During the past hundred years or so a variety of techniques has been devised for transmitting messages electrically from one point to another It is only of recent years, however, through the work of a few theoretically minded communication engineers, that means have been provided for assessing quantitatively the commodity which is transmitted, namely, the 'information' content of messages, and of determining the extent to which existing techniques fall short of what may be attainable This recent work proves to have a significance beyond the sphere of electrical communications A new branch of science is emerging which reveals and clarifies connexions between previously largely unrelated fields of research concerned with different aspects of the processes by which living organisms—in particular man—collect, classify, convert and transmit information A confluence of different fields of investigation is, of course, no new phenomenon in the history of science, but the wide recognition of a new connecting link can seldom have been so rapid as in the present case

With the view of affording an early opportunity for discussion of the nature and potentialities of this recent work among interested scientific workers and technologists, a symposium was held in the rooms of the Royal Society during September 26–29 The hundred and thirty members of the symposium included groups of mathematicians, statisticians, physicists, biologists, physiologists, psychologists and electrical engineers. Attendance from abroad, though limited by the available accommodation to twenty-five, was strong and representative, as may be judged from the names of Profs B van der Pol, G H Bast, H Dahl, P Grivet, B Haard and J L van Soest The two invited foreign speakers were Dr Claude E Shannon, of the Bell Telephone Laboratories, New York, and Prof. J B Wiesner, of the Electronics Laboratory, Massachusetts Institute of Technology. The other speakers were from Great Britain, but the visitors from the

Continent of Europe contributed extensively to the prolonged and lively discussions. Sir David Brunt and Profs H S W Massey, R A Fisher, W E le Gros Clark, E. D Adrian, J L van Soest and Dr. R. Cockburn acted as chairmen of individual sessions.

After Sir David Brunt had opened the symposium and welcomed the visitors in the name of the Royal Society, a short introductory address was given by the organizer, Prof Willis Jackson E C Cherry then presented a historical review of the evolution of the theory of information Starting from a discussion of languages and codes, he proceeded to the history of electrical communication techniques, and to the gradual development of what is now called communication theory After several workers from about 1924 onwards had shown the way for a determinate mathematical description of communication signals, Norbert Wiener and C E Shannon introduced the statistical aspect The 'terminal equipment' can be human or instrumental The generality of the concepts, and of their mathematical representation, lead naturally to inquiry into possible similarities between the information-handling abilities of the human brain and of calculating machines A further step leads to consideration of the reaction of the receiving system on the source of information, a field common to servo-mechanisms and living organisms, to which Norbert Wiener has given the name 'cybernetics'. Finally, the quantitative features and methods which have emerged from these studies throw light on the general problem of the assessment of information about Nature, that is, on experimental science in the most general sense of the term This is the subject of information theory proper, of which only some outlines are visible for the time being The fifty-three references which accompanied Mr Cherry's paper will be a welcome guide for those who wish to study the subject

Dr Claude Shannon gave a concise exposition of the statistical communication theory which he has formulated in a number of important publications[1]. The 'information'—not to be confused with 'meaning'—conveyed by a signal, whatever form this may take, is measured by its unexpectedness on the basis of a known statistical distribution, and is mathematically expressed by the 'selective entropy' of the ensemble from which it is taken *A priori* knowledge restricts this ensemble, and a judicious use of this knowledge may lead to economy in communication technique, by reducing the redundancy in the transmission Dr Shannon dealt particularly with his more recent researches, which suggest that, if account is taken of the long-range statistical structure of the English language, its redundancy may be as high as 75 per cent In a further, written, communication Dr Shannon gave a summary of his theory of coding, but his second lecture dealt instead with an entirely new contribution to the subject His new approach is related to J von Neumann's 'partition theory' of information, and to G Birkhoff's 'lattice theory'. The lattice is a collection of stochastic processes, represented by points in an abstract space, with a metric so determined that equivalent processes obtained by encoding operations reversibly from one another count as one point, and the distance between two points measures the statistical independence of the processes which the points represent If x and y are two processes, their interval is the sum of the conditional entropies $H_x(y) + H_y(x)$ It is hoped that the new approach will open the way to the difficult and practically important problem of using the reaction of the receiver for correcting errors in the transmission

An account of his investigations on the relation of communication theory to physics was given by Dr. D Gabor[2] Signals are restricted *a priori* by the method of physical analysis to a finite number of data, but there is no mathematical reason why the accuracy of the measurement of each datum should be limited There are, however, three physical reasons, corresponding to temperature, the discreteness of the elementary electric charge, and the finiteness of the quantum of action If all other, non-fundamental, sources of 'noise' are eliminated, there remains a fundamental uncertainty, which defines a scale of smallest distinguishable steps, similar to the scales used in physiology He showed also that quantum noise, unimportant at present in electrical communication problems, will be met with sooner than expected if progress continues towards higher frequencies

A contribution on "Quantal Aspects of Scientific Information", by D M MacKay[3], gave an appropriate frame for the unification of apparently divergent definitions of 'amount of information' *A priori* or structural and *a posteriori* or metrical information are complementary indexes of 'descriptive-content'. Both are quantized, the first by logical necessity, the second by noise or other physical causes of finite accuracy. Selective information is an index of statistical rarity, applicable to ensembles of descriptive patterns It may be hoped that the terminology which he presented in an extensive glossary will be used by future contributors to the subject.

Prof M S Bartlett gave an extensive review of the "Statistical Approach to the Analysis of Time-Series", a subject of great importance in communication theory and in scientific methodology. He reminded the audience that the first statistical definition of information was given by R A Fisher, long before the information (entropy) concept was introduced into communication theory, and discussed their respective association with inference and specification problems Statisticians are largely concerned with inference, and physicists with specification, but they may still have much to learn from each other Perhaps the most interesting contribution in Prof Bartlett's review concerns a method of smoothing in the harmonic analysis of time-series, which he has developed[4]

In a lecture on the "Theory of Radar Information"[5], P M Woodward gave an interesting illustration of the application of Shannon's communication theory by consideration of the problem of measuring the range of a stationary target He showed that there are two quite different conditions of reception—one, ambiguous reception in which the information-rate is high but the intelligibility low, the other, unambiguous reception in which the reverse is the case—and he suggested, therefore, that merely to evaluate quantities of information, and compare them with ideal limits, is not an adequate guide to the behaviour of a communication system Some figure of intelligibility may also be necessary in particular problems

Until quite recently the subject of noise in relation to electronic devices has been a highly controversial one, and much credit for its clarification must go to Dr D K C MacDonald, who gave a review of "Fluctuations and Theory of Noise". Considerable confusion has been caused by the 'time approach' and 'frequency approach' being considered as apparently independent, whereas both specifications contain

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essentially the same physical information. Another source of error, dealt with in the discussion, lies in the attempt to apply classical thermodynamics to electron stream problems where thermal equilibrium is not, in fact, attained

On the third day attention was transferred from branches of scientific effort in which information theory has already a secure foothold to those in which its application is still largely a matter of conjecture Dr D. B Fry spoke on the problems of linguistic theory, in particular on the problem of speech recognition Dr T Gold reviewed his and Prof R J Pumphrey's theory of hearing[6], for which important indirect supporting evidence has lately been forthcoming Dr W A H Rushton explained that some hundreds of retinal receptors share only a single nerve fibre to the brain, and yet provide an optic signal in which are encoded enough features of the observed scene, not only to stimulate automatic movements, but also to form the basis of visual judgment He asked, in effect, how the communication engineer would deal with such a situation using a line subject to the usual limitations of nerve transmission, namely, no frequency greater than 500 c/s and no variation in amplitude ? What are the features of a scene which, with these limitations, it would be most advantageous to abstract and transmit, and can theory lay down the conditions in which experimental observations will give definite answers ? Not surprisingly, these questions went unanswered, but they served to illustrate the emerging interrelationships Dr W E Hick showed that material collected by experimental psychologists on the dependence of choice reaction-time on the degree of choice permitted can be represented with remarkable accuracy by a logarithmic curve, as if the brain carries out the choice, for example, by a succession of binary selections, with fixed time for each Dr W Grey Walter gave a description of two electro-mechanical devices which he has constructed to provide an imitation of the superficial features of animal behaviour, and which demonstrated that a small number of receptors and effectors is sufficient to produce very complicated behaviour patterns Dr J A V Bates outlined some problems in neurophysiology on which speculation by communication engineers might be fruitful, and supplied a glossary for a first introduction of physicists and engineers to this field

Dr A Uttley reviewed the operation of computers as transformers or coders of information, and demonstrated in a striking manner that machines can already perform several functions previously regarded as attributes only of living organisms, such as learning from past experience, or recognizing abstract patterns, even of the type which are held to be tests of intelligence—interest in machines which can play games seems to be fairly widespread among the mathematicians who have made contributions to information theory Dr Shannon is engaged in constructing a machine which will not only play chess, but even improve its game A tentative theory of 'maximum mobility' was presented in an interesting contribution by Dr Eliot Slater on the basis of the statistics of master-games

On the final day, J H Westcott gave a lucid review of "Criteria of Prediction and Discrimination" In this field the pioneer work has been done by Norbert Wiener, but his criterion of 'least mean square error' is not always satisfactory Westcott advocated a 'time-weighted' criterion, which may prove superior once the mathematical difficulties connected with its application are overcome This was followed by a discussion opened by D M MacKay on entropy, time and information, in which the suggestion was made that the 'arrow of time' is determined by the direction in which our information increases The concluding talk was given by Prof J B Wiesner, who described the work being carried out in the United States and at the Massachusetts Institute of Technology in particular, on the difficult problem of speech recognition using 'visible speech', and on electronic correlators[7]

The subject-matter of the papers and of the discussions which followed their presentation is to be reproduced in composite form with the assistance of the Ministry of Supply, which also, with the support of the British Broadcasting Corporation, generously contributed to the costs of the symposium Applications for copies of the proceedings should be sent to the Electrical Engineering Department of the Imperial College of Science and Technology, London, S W 7, and will be met as equitably as possible from the limited number which can be made available

WILLIS JACKSON

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CONFERENCE ON BIOLOGICAL ANTIOXIDANTS

THE volume under review[*] contains the transactions of the Third Conference on Biological Oxidants held in New York in October 1948, and also a report on the Symposium des Lipides held in Paris during January 1948. In both, the familiar pattern of a verbatim record is followed This has both its advantages and disadvantages Comments and questions directed to the principal speaker are often the means of clarifying obscurities in argument or of eliciting speculations which add greatly to the value of the symposium Nevertheless, it must be admitted that the spoken word often lacks precision and that interpolations like 'Dr X, did you want to ask something?' can be irritating To the participants in the conference the situation would have been quite different.

There are in this volume ten papers, each followed by a discussion They range from a general introduction on "The Mechanism of Autoxidation and the Action of an Antioxidant" by L Michaelis to "The Mechanism of Action of Lipoxidase" by R T Holman, but, as was inevitable in any symposium on this topic, the biochemistry and biological action of tocopherol were never far out of the picture

A very interesting paper is contributed by the chairman, Prof Paul Gyorgy, on "Observations on the Biological Effect of Tocopherol in Living Organisms", in which he describes his experiences with various diets causing hepatic necrosis in rats and shows that not only methionine but also tocopherol can prevent the development of such necrosis He inclines towards the interpretation of their action as

[*] Biological Antioxidants Transactions of the Third Conference, Oct 7-8, 1948 Edited by Cosmo G Mackenzie Pp 146 (New York Josiah Macy, Junior, Foundation) 2 70 dollars

one of detoxication In the same paper he records that tocopherol administration to rats can prevent the hæmolytic action of alloxan, but not its necrogenic effect upon the pancreas

Another interesting paper is that by W. G Clark and T A Geissman on "The Role of Flavonoids and Related Substances in Biological Oxidations" The authors stress the important effects which may follow the capacity of substances of this class of chelating with metals such as iron, copper, cobalt and zinc

Taken as a whole, the volume is stimulating, although it is now some considerable time since the conferences took place One feels, perhaps, that the contributions might just as well have found their way into the recognized journals where they would have attracted the attention of both specialists and those more generally interested in these topics As it is, the volume recording the conferences is likely to find its way into the bookshelves of the specialists only They will no doubt be glad to have all the material conveniently assembled under a single cover

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NUFFIELD FOUNDATION

ANNUAL REPORT FOR 1949-50

DURING its first quinquennium the Nuffield Foundation selected and supported projects which seemed likely to advance the frontiers of knowledge in the medical, natural and social sciences, and particularly projects which seemed likely to contribute to the betterment of life Many of the Foundation's earlier interests are being further pursued or rounded off as part of its present programme. and the Foundation announced in its fourth annual report its intention of seeking opportunities of furthering the search for new knowledge, especially in the fields of biological and sociological studies, and also of supporting or initiating attempts to apply existing knowledge to practical problems of contemporary importance In its support of fundamental research, the Foundation has manifestly sought to assist work in fields which would often otherwise be neglected and thus to restore some balance in the advancing front of science

Not content with its earlier efforts to break into new ground, to nurture some of the more immediate post-war requirements of teaching and research in the United Kingdom, and especially to enable academic studies to be re-started and re-staffed on a scale sufficient to attract the research workers who had been drawn away during the War, the Foundation is now significantly broadening the scope of its benefactions. It has always recognized the importance of the universities in Britain being able to offer the fullest opportunities to postgraduate students from the British Commonwealth, but its own grants have been confined to research in Great Britain In its fifth annual report for the year ending March 31, 1950*, the Nuffield Foundation indicates that it is now considering the possibility of encouraging research in some of the Dominion universities and associated institutions It is pointed out that the help which the Foundation will be able to offer for research overseas is bound to be highly selective and limited in amount, and the first such grant for fundamental research overseas announced in this report is for £25,000 over ten years for the endowment of the Nuffield research chair of mechanical engineering in the New South Wales University of Technology The chair is intended to enable the Nuffield professor to concentrate on new developments in the theory and practice of mechanical engineering and on the solution, through the medium of mechanical engineering, of some of the problems obstructing the full economic development of Australia

The Foundation recognizes the important role of the universities of the British Commonwealth and the university colleges of the Colonies in training professional and technical leaders and in guiding and guarding the characteristic way of life and thought of the societies which they serve and help to mould , but the Foundation emphasizes that such work should receive recognition and encouragement from Great Britain The strengthening of academic links throughout the Commonwealth may affect the growth and spread of all those other activities in which Britain should be lending its great and much-desired influence Nevertheless, the new departure will not mean any slackening in the support given to work in Great Britain

Grants promised during this first year of the second quinquennium amount to £506,925, to meet which £377,425 has been allocated from the income of the year, in addition to previous grants totalling £135,000 Of this, £38,725 is for research in rheumatism from the Oliver Bird Fund, with a promise of a further £31,500 For fundamental research, £46,750 has so far been given to biological and £33,000 to sociological studies, while £225,300 has been allocated from the income of the year towards fellowships, scholarships and similar awards, to be operated over the whole quinquennium, leaving £173,000 to be met from the remaining years, £60,000 is to be paid as the remainder of the Foundation's promised share in supporting the National Corporation for the Care of Old People Miscellaneous grants totalling £19,300 include a further £16,000 to the Association of Universities of the British Commonwealth for travelling expenses in connexion with its annual meetings.

Grants in continuation of the past programme include, in the natural sciences, a new grant of £32,000 over a further three years, in termination of the original grant, to the Biomolecular Research Laboratory at Birkbeck College, London, where the studies envisaged include the investigation of the structure-types of the simpler compounds of biological importance, including those that might throw any light on protein and virus structure, and the systematic investigation of the low-molecular weight crystalline proteins and of crystalline viruses. The electronics department of the Laboratory is concentrating on the improvement of electronic and associated techniques and the investigation of the electronic properties of dielectrics and semi-conductors, while the electronic-computing section is attempting to reduce the time required for the laborious computations needed for crystal structures and to make possible computing of protein and virus work which could not be carried out at all by existing methods For additional work on the physiology of learning at the Department of Anatomy, University College, London, an extra grant of £370 a year for two years has been made and £3,000 has been allotted to the inquiry into the fundamental principles that should be applied in shaping agricultural policy for Great Britain A further grant of £2,000 over three years has been made towards the pilot surveys being conducted for the Third Statistical Account of Scotland

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* Nuffield Foundation. Report for the Year ending 31 March, 1950 Pp 86 (London Nuffield Foundation, 1950.)

Grants from the Oliver Bird Fund, totalling £48,800, have been allocated for a programme of research on cortisone, the pituitary adreno-corticotrophic hormone and similar substances, as well as a further £8 825 for other researches into rheumatism In this work the Foundation is maintaining the closest possible liaison with the Medical Research Council, and representatives of the pharmaceutical industry have been approached with a view to even wider collaboration, by pooling the results of commercial and academic research upon the problems presented by cortisone and adreno-corticotrophic hormone This programme comprises a grant of £1,000 for apparatus and £10 000 over three years to the School of Biochemistry, Cambridge, for work on the isolation and purification of the pituitary adrenocorticotrophic hormone, its fission into peptides, and a study of their composition, structure and synthesis, as well as £5,000 over three years to the University Chemical Laboratory for research on the synthesis of biologically active related peptides and on the synthesis of compounds with cortisone-like activity. £10,000 for three years has been granted to the Dyson Perrins Laboratory, Oxford, for a project for the partial or total synthesis of cortisone and analogous substances, and £1,000 for two years to the School of Chemistry, Royal Technical College, Glasgow, for an investigation of materials other than bile-acids as a source of cortisone-like substances. The programme also provides £800 a year for three years to the Rheumatism Research Centre, Manchester, for technical assistance in recording clinio-physiological data on the effect of cortisone and adreno-corticotrophic hormone , £5 000 over three years to the Department of Biomolecular Structure, Leeds, for intensive examination of arthritic lesions supplied by the Rheumatism Research Centre , and £10,000 over five years to the research unit to be set up by the Department of Medicine, St Mary's Hospital School, London, for study of the action of cortisone and adreno-corticotrophic hormone on various other disease states

New grants for fundamental research in the biological sciences include £8,250 over five years to the Department of Zoology, King's College, London, for the study of the differentiation between cell-types by nuclear and cytoplasmic transplantation, and by cytochemical methods , £10,000 to the Department of Anatomy, University College, London, for a five-year continuation of the research into the physiology of learning and the addition of an electronic engineer to the Department , £15,000 for five years to the Laboratory of Chemical Crystallography, University of Oxford, for the formation of a research unit equipped with calculating machinery and computing assistance for the X-ray analysis of crystals of complex compounds , and £12,000 over five years to the trustees of the Strangeways Research Laboratory, Cambridge, for research on the structure and physiology of living cells, with special reference to the problems of cell division, and experimental investigation into the processes of cellular differentiation.

In the sociological field, the Foundation has provided £6,000 for an inquiry over three years by the Department of Economics, Aberdeen, into the budgets of young childless couples, married couples having their first child and married couples having their second baby, as well as £12,000 over three years for a systematic research, in collaboration with the Tavistock Institute of Human Relations, on the development of various patterns of family life and the relative contribution of individuals and community to these patterns A grant of £10,000 has been promised to the London School of Economics and Political Science to meet for five years staff salaries for the new Division of Research Techniques The principal concern of the Division will be research in the application of statistical techniques to social data and the study of sampling and interviewing techniques A grant of £5,000 has also been made to the joint mental-survey committee of the Population Investigation Committee and the Scottish Council for Research in Education to follow the careers of the 12,000 sample children for the five-year stage until they reach eighteen years of age

For the first stage of an investigation into the consistency of stop-watch time studies, to be conducted with a steering committee under the chairmanship of Sir Frederic Bartlett, the Foundation has set aside £2,000 The dental fellowships and scholarships and the Dominion travelling fellowships schemes are continued unaltered, but a new scheme of United Kingdom medical fellowships has been instituted, under which the emphasis is changed to future teachers and research workers A new scheme of travelling fellowships for the Home Civil Service has been introduced, under which three fellowships a year are offered to Civil servants at the principal and assistant-secretary levels—and equivalents in the scientific grades—to visit other parts of the British Commonwealth for six months to a year. The first selection took place in March 1950

Finally, there is foreshadowed in the report a scheme for extending the Nuffield Foundation Dominion travelling-fellowships—already in operation for Australia, Canada, South Africa and New Zealand—to the new Dominions of Ceylon, India and Pakistan. Since the report was published it has been announced that the following awards have been made : Ceylon, one fellowship (in medicine) , India, five fellowships (two in medical sciences, and one each in engineering, natural sciences, and social sciences) , Pakistan, three fellowships (subjects not yet selected) The object of the travelling-fellowships, which are open to men and women graduates, is to advance the interests of the new Dominions and to strengthen further their academic ties with the United Kingdom The fellowships last for one year, and, according to whether the holder is married or single, are worth £770–890, in addition to travelling expenses (for a wife as well) to and from Great Britain.

COTTON RESEARCH STATION, NAMULONGE, UGANDA

As announced in *Nature* of November 18 (p 850), the Parnell Laboratories at the Empire Cotton Growing Corporation's new Cotton Research Station at Namulonge, near Kampala, Uganda, were officially opened by H E Sir John Hathorn Hall, Governor of Uganda, on November 9 Among the large gathering of guests who witnessed the ceremony were H H. the Kabaka of Buganda and the Nabagereka, Sir John and Lady Russell, Dr and Mrs B A Keen, Dr H H Storey, and Mr G W Nye, representing the Secretary of State for the Colonies. Mr F R. Parnell, the first director of the Station, and Mrs Parnell were present, and also Mr Arrowsmith, of the Raw Cotton Commission, Mr Killick, of the Cotton Board, the directors of agriculture or their representatives from Kenya, Nyasaland, Tanganyika and Uganda, the director of agriculture and the chief of the Research Division from the Sudan, representatives from the Belgian Congo and French territories in Africa, and senior research officers of the Corporation from the Sudan, Tanganyika and Nyasaland

The Namulonge Station, the director of which is Dr J B Hutchinson, comprises 2,240 acres of land, excellently situated for experimental work on cotton and the food crops associated with it in the Buganda agricultural system Ten staff houses and a guest house have been completed and occupied, and three more are in course of construction The laboratory block was named by H E the Governor after Mr F R Parnell, the first director The building is designed to accommodate twelve research officers and to provide facilities for visiting workers and research students

The day following the official opening was devoted to technical discussions and tours of the field experiments In the afternoon, the first meeting of the African Advisory Board of the Station was held and was attended by directors of agriculture and senior research officers from Kenya, Tanganyika, Nyasaland, Uganda and the Sudan The first progress report of the station was received, and the research programme discussed

Research is planned in crop husbandry and physiology, entomology, plant pathology and plant breeding and genetics Crop husbandry work will be concerned primarily with the task of fitting cotton into a balanced farming system, in which native food crops, grass-resting leys, and stock keeping will all have their place Cotton physiology studies will start from a consideration of the crop environment, and comprehensive meteorological data are being collected. Work on the effect of water and nutrient supply and of leaf area on plant development and cropping capacity will follow, and will be linked up with studies on the physiology of lint development, and the genetic and environmental control of cotton quality.

The entomological programme includes studies of the bionomics of cotton pests, fundamental investigations in insect physiology, and work on the technique of pest control by insecticides This last will be carried out jointly with the East African Agricultural and Forestry Research Organization

The main problems in plant pathology are those of the epidemiology of bacterial blight, and of wilt diseases The practical solution to both types of disease lies in the breeding of resistant varieties , but progress in breeding work will be slow and uncertain until the factors governing outbreaks of disease are understood, and the physiology of resistance has been elucidated

Plant-breeding work includes the breeding and first multiplication of pedigree stocks of the commercial Uganda variety *BP*52, the transfer of genes conferring resistance to bacterial blight to East African commercial stocks, and the synthesis of heavy-cropping stocks for further selection at territorial stations

Long-range genetical research is carried on at Shambat, near Khartoum in the northern Sudan, by arrangement with the Sudan Government The maintenance of the very extensive *C R S* collection of the world's cottons, and of wild species of *Gossypium*, is easier under the irrigated conditions of the northern Sudan than under rain-fed cropping in Uganda, and the possibility of growing two generations a year increases the rate of progress in genetic research

At the meeting of the Advisory Board, discussion centred around the allocation of cotton research problems between territorial stations and Namulonge, and agreement was reached on general principles, and on detailed arrangements as they affect the Namulonge programme for the coming year.

NEW AUSTRALIAN HOUSE AT KEW

THE flora of Australia is certainly one of the most interesting and scientifically important floras of the world It is naturally an extensive one, though when George Bentham produced at Kew the "Flora Australiensis" between the years 1863 and 1878, its seven volumes contained descriptions of less than nine thousand species of vascular plants, a number far exceeded by the known flora of to-day For example, in the genus *Acacia* alone Bentham recorded 293 species compared with nearly twice that number now known to botanists It is a flora notable for the rich representation of such families as Proteaceæ, Myrtaceæ and Rutaceæ and such genera as *Hibbertia* and *Drosera*, with a wealth of endemics that are fitting parallels to the marsupials and monotremes in their morphological interest and taxonomic isolation The Australian flora includes species growing in a wide range of climatic conditions from the high rainfall areas of the south-west, where the giant blue gums grow to a height of more than three hundred feet, to the arid regions bordering on the Nullabor and central plains where vegetation may be said to flourish although it must endure an erratic rainfall that averages seven inches or less yearly It is under these latter conditions that one encounters the amazing examples of homomorphy where species of many unrelated families appear remarkably alike until production of flowers discloses their individuality.

During the period of the Second World War, Captain and Mrs McEacharn were forced to leave their famous garden, the Villa Taranto in Italy, when that country entered the War They occupied the time of their enforced exile in Australia, where they collected seeds assiduously for the Royal Botanic Gardens, Kew The outcome was a collection of several hundreds of species, including a very large number not previously in cultivation The difficulty of growing many species from the Antipodes is notorious, especially in the early stages , nevertheless, plants of the majority have been successfully raised, including many Proteaceæ

The very crowded conditions in the existing Temperate House at Kew, despite its large size, have necessitated further accommodation and a new house to provide for these valuable additions Such is now in course of construction and it is expected to be completed by next June It will be about ninety feet long by some fifty feet in width and will permit the growth of specimens in the central beds nearly thirty feet in height By the use of aluminium it is hoped to ensure a more adequate illumination than the utilization of a timber framework permits

Not only will the requisite new space thus be made available, but it will also be possible to achieve the segregation of the temperate species of the more arid environments from those which benefit by more humid conditions in a degree not previously possible.

When the present director of the Royal Botanic Gardens, Kew, was in Australia in 1949 and visited the various botanical centres in the Dominion, he found widespread interest and pleasure when the news of this project was made known, and this elicited spontaneous offers of further material. He brought back with him plants of the unique *Cephalotus follicularis*, which has pitcher leaves resembling those of *Nepenthes*, although the two families are in no degree related, and also specimens of that remarkable endemic Lycopodiaceous plant, *Phylloglossum drummondii*, which was found in a new locality.

The creation of a new post in the Herbarium, the occupant of which will be wholly concerned with the Australian flora, and the provision of this additional space for the culture of living material are important recognitions of the scientific significance of the vegetation of the Australian Commonwealth.

ROWETT RESEARCH INSTITUTE

EXTENSIONS TO BUILDINGS

IN 1945, Dr. D. P. Cuthbertson succeeded Sir John Orr, now Lord Boyd-Orr, as director of the Rowett Research Institute, near Aberdeen. During the War, the Institute's investigations into problems of animal nutrition were greatly curtailed, and the new director's first task was to plan a long-term programme of research in the light of new developments in science and the economic conditions of Great Britain.

Nutrition is a meeting ground of many scientific disciplines, and to decide which of these should be represented in the Institute posed a difficult selection. The choice was influenced by what was desirable and by the men and women who were willing to interest themselves in nutritional research. After five years of steady development, the Institute now includes the following departments or sections: physiology, agricultural chemistry, protein and carbohydrate chemistry, enzyme chemistry, microbiological chemistry, pathology, bacteriology, helminthology, animal behaviour, sheep husbandry, pig husbandry, dairy-cattle husbandry, statistics, radiology and photography. It shares an experimental farm of about a thousand acres with the North of Scotland College of Agriculture and the facilities of its Reid Library with the Commonwealth Bureau of Animal Nutrition. The scientific staff, which numbered nineteen in 1939, has increased to forty-nine. This growth required new laboratory accommodation and considerable adaptation of existing laboratories, animal houses and byres. In view of the shortage of building materials and labour, an ingenious compromise was made between the desirable and the attainable. Until a year ago the laboratories were accommodated in a building with a flat roof which was in need of extensive repairs. To deal with this situation, Mr. A. G. Ingham, chief architect of the Department of Agriculture for Scotland, produced an ingenious design for a new storey which would use the minimum of material, make the roof sound and provide new laboratories. This extension, now nearing completion, was formally opened on November 18 by Lord Strathcona and Mount Royal, an old friend and generous benefactor of the Institute.

During the same week-end the activities of the Institute as a social and collegiate centre were also furthered by the opening of a new wing of nine bedrooms, a much desired extension of Strathcona House, which is the residential club in the grounds of the Institute. The formal opening of this extension was also done by Lord Strathcona. As a recognition of Lord Strathcona's many services to the Institute, he was presented with his portrait in oils, painted by Sir Oswald Birley. These ceremonies coincided with the annual reception and dinner in honour of the founders of the Institute.

UNIVERSITY POPULATION OF GREAT BRITAIN

IN its fourth report for the session 1950, the Committee of Public Accounts returns to a point made by the Committee in its third report for the session 1948–49, referring to the possibility of some more effective means of securing adequate Parliamentary control over the large grant-in-aid to universities and colleges in Great Britain, which has risen from £1,680,000 in 1932–33 to £17,564,500 in 1949–50 and £23,284,150 for 1950–51. While in that report the Select Committee accepted the Treasury view that the grants need not be specifically authorized by statute and that it was not possible to present the estimates for the vote and the account in comparable form, it asked that the Treasury should consider whether, without impairing the independence of the universities, any further means could be adopted for informing Parliament how the grant-in-aid proposed in the estimate is to be spent.

In a minute of February 27, 1950, the Treasury referred to the publication of periodical reports by the University Grants Committee on university development, and of returns from the universities of financial and other statistics, and said that it was not clear what further steps could be taken to enable Parliament to judge of the wisdom with which the grants are used. Some support for this attitude is forthcoming from the publication of the "Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1948–49", recently issued*. When placed in comparison with the returns for the previous year, save in respect of Oxford and Cambridge, for which college incomes are excluded, the figures seem to supply reasonably adequate information. If this were supplemented, either in the returns or in reports from the University Grants Committee, by some more information about results obtained from certain of the larger non-recurrent ear-marked grants for new developments, the substance of the Select Committee's criticism would seem to be met.

In justification of the Select Committee's observations, it must be recognized that, leaving out of account college income, even at Cambridge 46 per cent and at Oxford 51 per cent of the total income of the university came from Parliamentary grants. The Treasury, however, has undertaken, when the present quinquennium for which the grants have been allocated ends in July 1952 and before future arrangements are settled, to make a very close review in conjunction with the University Grants Committee of what has been achieved, and to examine in detail the question of possible extravagance What must be avoided, however, is the sort of financial accountability which will endanger the originality and creative thought that the universities must safeguard at all costs and which would be a costly forfeit for saving a million or two of the taxpayers' money.

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* University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1948–49. Pp. 26. (London: H.M. Stationery Office, 1950.) 2s. net.

The income of the universities of Great Britain for the academic year 1948–49 amounted to £18,156,578, of which 6 7 per cent was represented by endowments, 1 9 per cent by donations and subscriptions, 5 per cent by grants from local authorities, 59 2 per cent by Parliamentary grants, and 20 6 per cent by fees The total income for English universities was £14,588,360, of which £5,337,745 was for London, £1,664,926 for Cambridge, £1,332,674 for Oxford and £6,253,015 for provincial universities and colleges The total income for Wales was £871,441 and for Scotland £2,696,777 Compared with the previous year, total income rose by £1,880,292, chiefly by increases of £1,338,923 in Parliamentary grants and £262,230 in fees, which now represent 59 2 per cent and 20 6 per cent, respectively, of the total income Income from endowments increased by £18.166

Of the total expenditure of £18,022,094, the sum of £323,305 represented allocations to reserve, and the remainder was distributed as follows administration, 9 2 per cent , departmental maintenance, 66 3 per cent , maintenance of premises, 11 7 per cent , capital expenditure met from income, 2 2 per cent , other maintenance expenditure, 10 6 per cent, the largest item under the last head being again the cost of the ordinary university examinations. Library expenditure totalled £533,086 for England, £23,351 for Wales and £76,818 for Scotland, approximately 3 6 per cent of the total expenditure, an increase of £82,379 on the previous year No university deviated appreciably from this percentage , although in some of the London institutions the percentage reached more than 30, the average for all London institutions was 3 4. Figures for the three technical institutions shown were much lower, although that of 0 6 per cent for the Imperial College of Science and Technology appears to be attributed to ready access to the Science Library at the Science Museum Of the total expenditure on libraries, £340,298 is on account of salaries and wages, £162,091 on account of books and £64,774 for periodicals Only seven universities, Oxford (£28,328), Cambridge (£10,425), Birmingham (£7,648), London (£6,674), Edinburgh (£6,524), Manchester (£6,257) and Leeds (£6,139) spent more than £5,000 on the purchase of books

The full-time teaching staff increased from 6,536 to 7,390, and although the number of full-time students increased by 5,103 to 83,690, there is thus a welcome increase in the ratio of staff to students The increase in staff was made up of 85 professors, 563 lecturers, and 17 assistant lecturers and demonstrators, with a decrease of 7 in the number of readers, assistant professors and independent lecturers Of the students, while there were 5,237 more men, there were 54 fewer women , although there was an increase of 204 women in Scotland These were distributed as follows arts, 44 4 per cent , pure science, 19 2 per cent , medicine, 16·8 per cent , technology, 13 per cent , agriculture, 3 5 per cent , dentistry, 3 1 per cent. Of these 83,690 full-time students, 6,452 were engaged in research and other advanced work, 68,307 were reading for a first degree and 8,931 for a diploma , 61,554 were in England, 5,149 in Wales and 16,987 in Scotland, the English total comprising 15,082 at Oxford and Cambridge, 16,884 at London and 29,588 at provincial universities and colleges Only at the University of Oxford was there a slight decrease in the number of full-time students The proportion of full-time students residing in colleges and hostels was 22 7 per cent (18 9 per cent for men, 35 6 per cent for women), while 38 2 per cent were in lodgings and 39 1 per cent at home Of overseas students from within the British Commonwealth, 3,335 were full-time and 1,492 part-time , a further 2,589 full-time and 1,162 part-time students came from foreign countries Cambridge again took 669 and Oxford 693 of these full-time students, Edinburgh 498, the London School of Economics 413 and University College, London, 375 A total of 24,826 full-time students was admitted for the first time during the year, an increase of 1,319 on 1947–48 There was little change in the general outlines of the distribution during the year , but there were 2,006 more men and 76 fewer women in arts, 575 more men and 159 more women in medicine and dentistry, 1,609 more men but 54 fewer women in pure science, 763 more men and 25 fewer women in technology and 284 more men but 58 fewer women in agriculture Of the full-time students, 73 7 per cent were receiving assistance from Government departments, local authorities, universities or other bodies during the year, the percentage for England as a whole being 76, for Wales 81 8 and for Scotland 62 9 For the provincial universities, the figure (78 8) was slightly less than for either Cambridge (79 8) or Oxford (81 7), but higher than in the University of London (66 7)

Of the 18,180 part-time students, 4,335 were engaged in research or other advanced work, 2,171 were reading for a first degree and 2,826 for a diploma. Of such students engaged in advanced work 45 8 per cent were in medicine (including dentistry), 30 7 per cent in pure science and mathematics, 12 6 per cent in technology and 0 7 per cent in agriculture, a distribution contrasting markedly with that for full-time advanced students of 37 6 per cent in pure science and mathematics, 9 1 per cent in medicine (including dentistry), and 3 1 per cent in agriculture, although the figure for technology (13 3 per cent) is similar.

SCIENTIFIC CO-ORDINATION IN THE SOUTH PACIFIC

THE welfare of the island peoples in the South Pacific has become the objective of a six-nation co-ordinated undertaking known as the South Pacific Commission Recognizing the mutual nature of many of the problems in the areas they administer, Australia, France, the Netherlands, New Zealand, the United Kingdom and the United States have joined in organizing the Commission to " encourage and strengthen international co-operation in promoting the economic and social welfare and advancement of the peoples of the non-self-governing territories of the South Pacific region ." (*Science*, 3 , May 26, 1950)

A research council has been established as an integral part of the Commission. Four specialists have been engaged to devote their full time to the undertaking, and other specialists will be retained to implement specific needs

Projects to further the aims of the Commission are proposed after research by the council experts They not only investigate the requirements of the area but also call on administrators and others who know the needs in the various territories to make recommendations, one of these suggestions led to the Seventh Pacific Science Congress which was held in New Zealand early in 1949 Council members are also guided by recommendations outlined by the commissioners representing member Governments Proposals made for projects are submitted for final approval to the commissioners, who assemble for sessions twice a year The four full-time members of the research council are assisted by a body of associate members, the full council meets annually to consider problems and needs of the South Pacific and to pass on projects to be submitted to the commissioners

At the May 1949 session of the commissioners twenty-eight research projects in health, economic and social matters submitted by the research council were approved for action Some of the projects are of an immediate nature, others will be developed on a long-term basis

Financial support for the Commission comes from the member Governments, contributions to the annual budget being made as follows Australia, 30 per cent, France, 12½ per cent, the Netherlands, 15 per cent, New Zealand, 15 per cent, the United Kingdom, 15 per cent, the United States, 12½ per cent The budget for 1950 was slightly in excess of £144,000 sterling

Technical assistance to the various territories in its area is of vital concern to the Commission Although the organization is entirely separate from the United Nations, liaison is maintained with that body and such of its affiliated and subsidiary bodies as will have common concern in the South Pacific This is particularly true in regard to the World Health Organization, the Food and Agriculture Organization, and the Indo-Pacific Fisheries Council The South Pacific Commission is modelled on its successful prototype in the western hemisphere, the Caribbean Commission, several of the same member Governments being concerned.

ONTARIO RESEARCH FOUNDATION

ANNUAL REPORT FOR 1949

THE annual report for 1949 of the director of research of the Ontario Research Foundation[*] characterizes the year as one of transition to conditions which from an economic point of view are regarded as more normal The fellowship work of the Foundation continued at a high level, though sometimes the absence of men and women with specialized postgraduate experience prevented the establishment of a new fellowship The short-term work in the laboratories continued to grow, largely due to the work of the Department of Industrial Research Services, which was utilized by 1,910 different companies on 2,853 occasions, laboratory work being involved in about half of these This assistance to the smaller industrialists is paid for by them on a reasonable basis of cost. A list of papers published during 1949 is appended, together with the balance sheet and statement of income and expenditure.

In the Department of Biochemistry progress is reported in the investigation of the chemistry of flavone reversion in linseed and other vegetable oils, of the effect of oxidation on the infra-red spectra of hydrogenated and unhydrogenated oils, and the formation of *trans* isomers of fatty acids during the polymerization of linseed oil An X-ray method for the non-destructive testing of footwear used by the Armed Services has been devised, involving the use of treated thread which is clearly visible in a fluorescent screen, the thread being also made resistant to moulds by the treatment A new laboratory was organized to study problems associated with the making of tomato products

Considerable attention has been given to the organization of the laboratories in the Department of Chemistry which are responsible for short-term work Investigations of the repair of methyl methacrylate dentures under the dental materials research fellowship have been concluded and the results published, while work on the use of methyl methacrylate for direct intra-oral fillings has been concerned mainly with methods for providing the localized heating necessary for polymerization *in situ*. Detailed reports have been made on the essential oils from the foliage of black spruce and hemlock trees, and considerable progress has been made in the study of the chemistry of white birch

The Department of Engineering and Metallurgy has maintained basic research fellowship projects and short-term investigations at a high level, but has been obliged to reduce to a minimum purely routine service such as specialized heat treatment The latest type of Bausch and Lomb metalloscope has been added to the equipment for metallography, and the Department has been asked to investigate possible methods of reducing coke consumption in Canadian blast furnaces by the use of electric smelting equipment. An investigation initiated into the non-destructive testing of metals has led to the discovery that failure can be predicted long before it occurs by tracing the changes in the magnetic properties of steel parts

In the Department of Parasitology the work on the protozoan blood parasites of birds has been almost entirely confined to the species occurring in wild ducks The work on *Ascaris lumbricoides* has been directed towards isolating a substance which will protect against infection Preliminary investigations have been made of the conditions responsible for 'swimmers' itch' or cercarid dermatitis which has a wide but irregular distribution The Department of Physiography has been concerned chiefly with details associated with the publication of the physiographical map of southern Ontario and the accompanying monograph

In the field of textiles, the fellowship sponsored by Courtaulds (Canada), Ltd, has completed a thorough study of statistical methods for determining the sizes of women's garments and has investigated the density, swelling and regain of viscose rayon yarns The York Knitting Mills fellowship has been concerned chiefly with designing and assembling the equipment for a fundamental study of principles involved in the commercial production of worsted yarn, and the Canadian Industries, Ltd, nylon fellowship has been devoted to a study of those properties of the nylon fibre which determine the commercial properties of the finished fabric Some independent work has been commenced on the elastic properties of textile fibres, for which purpose nylon is being investigated first.

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[*] Ontario Research Foundation Annual Report for 1949. Pp 24 (Toronto: Ontario Research Foundation 1950)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Origin of the Moon

THE resonance theory of the origin of the moon was reduced to a state of low probability by work of Jeffreys[1] in 1930. The calculations of Jeffreys were based on the assumption of a velocity of slip between the central core and mantle of the primitive earth–moon body, and implied that energy would be dissipated at the core boundary several hundred times faster than could be allowed if the needed amplitudes were to be developed through resonance.

Recent work[2,3], however, suggests that certain aspects of the resonance theory may well be re-examined in the light of the hypothesis that the discontinuity in density between the earth's mantle and central core is caused primarily by pressure rather than by change of material from ultrabasic rock to nickel–iron. In these circumstances, there would not be a slip-velocity over the boundary in the form assumed by Jeffreys. There would, of course, still be dissipation of energy at the boundary as the density changed suddenly in the process of adaptation to the strained configuration arising during resonance, and it is practically certain that this dissipation would still be sufficient to stop the birth of a moon by the direct resonance process. But a new calculation of the amount is desirable.

The recent work mentioned has, however, further implications. Ramsey[2] has shown that if the existence of a core in a planet is due primarily to pressure instead of chemical change, then a planet with a relatively small core would be gravitationally unstable. Ramsey[4] considers that not only is the density change at the outer boundary of the earth's core a transition caused by pressure, but also that the phenomenon is repeated at the boundary of the inner core. Other work[5] favours (slightly) the contrary hypothesis that the inner core, though not the rest of the central core, is chemically distinct from the mantle. One possible way of reconciling the two views is to suppose that a second transition, instead of being responsible for the earth's present inner core, would have been associated with a further discontinuity surface once present in the earth, but since removed. This provides the basis for a new theory of the moon's origin.

The theory I wish to propose is that, inside the central core of a primitive earth–moon body, there was an additional high-density region, no longer present in the earth, caused by pressure, and in such proportion that the body was near a state of instability. Resonance would now be called upon to fill the role of partial rather than full responsibility for the disruption which led to the birth of the moon. The idea would be that resonance would, so to speak, first act as a trigger effect to take the primitive body through a potential barrier and so lead to instability. The gravitational energy thereby made accessible might then possibly be sufficient to result in the ejection of the moon; but even if it were not sufficient, resonance would still be available in conjunction with the changes of gravitational energy to supply additional energy for the purpose.

It may be remarked that, suitably modified, the theory can be made independent of differences between views of the nature of the present earth's inner core. For example, if the inner core proves to be actually due to a second transition caused by pressure, then the theory might envisage a third such transition inside the primitive body. In fact, it is possible, until quantitative checks have been made, to suggest several minor variations of the theory.

Ramsey (in a paper in course of publication, kindly sent to me) has given some attention to the question of the origin of meteorites and the asteroids, and estimates that, for the case of a planet with a single homogeneous small core, the energy that could be released through instability would correspond to the ejection of a quantity of matter somewhat more than 0.001 of the mass of the earth. The new theory here proposed for the origin of the moon will be quantitatively satisfactory if this factor 0.001 can be raised to the order of 0.01.

Several auxiliary investigations are necessary to test how far the factor can be raised. These include (i) the extension of Ramsey's calculations to the more complicated type of central core envisaged in the theory here presented; (ii) investigations of instabilities in relation to the distorted configurations that would be brought about through resonance; (iii) estimates of rates of energy dissipation due to all causes.

Some parts of the needed investigations depend on data on the earth's interior which are not as yet available, and in other parts there are mathematical difficulties. Thus it may be some time before this new theory can be put on a precise quantitative footing. But, in the meantime, it seems that some of the implications of the resonance theory of the origin of the moon in geology and geophysics should receive more attention than has been the case over the past twenty years.

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[1] Jeffreys, H., *Mon. Not. Roy. Ast. Soc.*, **1**, 169 (1930).

[2] Ramsey, W. H., *Mon. Not. Roy. Ast. Soc.*, **108**, 406 (1948).

[3] Bullen, K. E., *Mon. Not. Roy. Ast. Soc.*, **109**, 457 (1949).

[4] Ramsey, W. H., *Mon. Not. Roy. Ast. Soc.*, *Geophys. Supp.*, **5**, 409 (1949); *ibid.*, **6**, 42 (1950).

[5] Bullen, K. E., *Mon. Not. Roy. Ast. Soc.*, **109**, 688 (1949); *ibid.*, *Geophys. Supp.*, **6**, 50 (1950).

An Analogue Multiplier

IN practically all analogue computer work there seems to arise the problem of multiplying two time-varying voltages. There are quite a number of methods of performing this multiplication and some of them fulfil the requirements of general analogue machines: (1) preservation of sign; (2) frequency response at least as good as other components in the machine; (3) voltage-levels high and output impedance low; (4) error having a maximum of 0.1–1.0 per cent.

The problem of multiplier design is somewhat more difficult if to the above requirements are added the following ones: few, if any, unusual techniques, critical voltages or high-precision or rare equipment required; small consumption of power, and the unit to be small and inexpensive enough so that several may be used.

There are several identities that facilitate electronic multiplication. The one used herein is

$$xy = \frac{(x+y)^2 - (x-y)^2}{4},$$

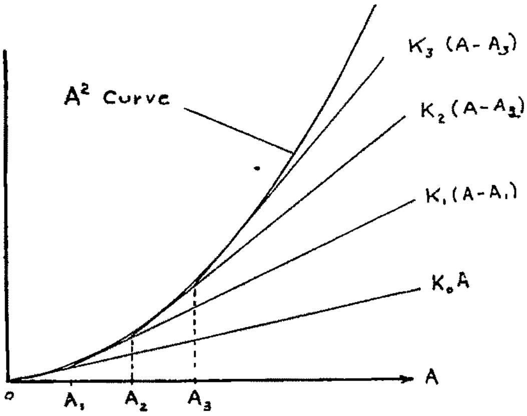

Fig 1

which retains its sign in spite of the squaring process Also it converts a function of two variables into a pair of functions of one variable voltage each The three additions (subtractions) are easily performed, as is the division by 4, but the square law devices require more consideration Fortunately there exists a technique for squaring a voltage that does not depend upon the square-law characteristic of a vacuum tube and the like, and which can, with additional equipment, be made as accurate as one wishes This is the method of straight line curve approximation with clipping diodes, which works particularly well with monotonic curves Fig 1 shows the lines used to approximate to the square-law curve The voltage A is either one of the terms in the identity given earlier For different ranges of the voltage A, the approximating curve is ·

$O \quad A \; A_1$ output voltage K_0A
$A_2 \; A \; A_2$,, ,, $K_0A + K_1(A-A_1)$
$A_2 \; A \; A_3$,, ,, $K_0A + K_1(A-A_1) +$
$K_2(A-A_2)$, etc

As shown in Fig 2, the portions of A, that is, K_0A, K_1A, etc , are taken from a voltage divider network These are fed to a diode clipping circuit, the clipping voltages being K_1A_1, K_2A_2, etc The output of the clipping circuit will be

the clipping voltage, K_nA_n, if $K_nA = K_nA_n$,
or the diode input voltage, K_nA, if $K_nA = K_nA_n$,

which is one term of the 'expansion' given above provided K_nA_n is subtracted Fortunately, for a square-law curve all of the K_n's are equal and the A_n's are at equal intervals Using this technique, it is possible to approximate to the square-law curve from zero to 100 volts with only eleven crystal diodes with a maximum error of 0 1 volt To cover negative values of the argument, another set of eleven is required

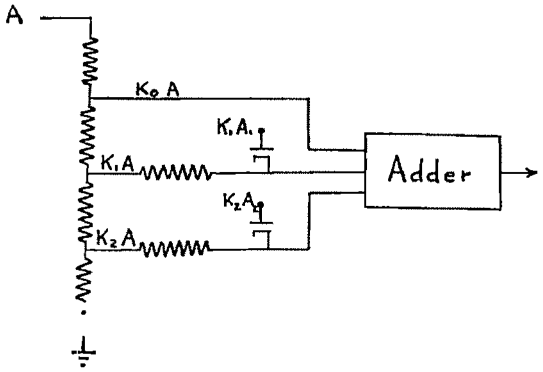

Fig 2

It might at first seem that the 0 1-volt error would be a large percentage error when operating in the region near zero However, two square terms are being subtracted and the error in the final product is, with the exception of a very small range of values, considerably less than one per cent Such a multiplier has been built and has operated very satisfactorily Aside from the diodes and resistors used in the approximating circuit, the multiplier contains four adding amplifiers, the whole unit being mounted on a chassis 11 in × 14 in It seems to fulfil all the requirements given in the first paragraph Its response time is limited mainly by the amplifiers and may be made better than the computer itself Even though components were not particularly selected, the maximum error was better than expected and well below one per cent

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Temperature Stresses in Irregular Solids

Hitherto it has not been possible to express temperature stresses in a form capable of numerical solution, in an axially symmetrical body of irregular shape in which temperature variations occur in both the radial and axial directions Such conditions are present in solid rotors of turbines, a problem which has been the subject of study here and elsewhere The three points of difficulty were (1) irregular boundaries, (2) temperature gradients in two directions at right angles, and (3) transient state of temperature distribution. Stress functions suitable for use with the relaxation technique could not be found where those conditions held

The difficulties have now been overcome, and a convergent numerical solution can be obtained by using stress functions X and Ψ, where

$$I^2X = 0, \text{ and } \frac{\partial^2 X}{\partial z^2} = I^2\Psi + \frac{r}{1-\sigma}\frac{\partial}{\partial r}(EkT)$$

throughout any axially symmetrical system, I^2 being the operator, $\left(\frac{\partial}{\partial r^2} - \frac{1}{r}\frac{\partial}{\partial r} + \frac{\partial^2}{\partial z^2}\right)$

In that case the boundary conditions are . $\Psi = 0$, and

$$\left(\frac{(1-\sigma)X}{r^2} - \frac{1}{r}\frac{\partial X}{\partial r} - \frac{1}{r}\frac{\partial \Psi}{\partial r} - \frac{EkT}{1-\sigma}\right)\cos(rv) - \frac{1}{r}\frac{\partial \Psi}{\partial z}\sin(rv) = 0,$$

the temperature stresses being as follow

$$\text{Shear stress} = -\frac{1}{r}\frac{\partial \Psi}{\partial z} \qquad \text{Axial stress} = \frac{1}{r}\frac{\partial \Psi}{\partial r}$$

$$\text{Radial stress} = \frac{\Psi + (1-\sigma)X}{r^2} - \frac{1}{r}\frac{\partial}{\partial r}(\Psi + X) - \frac{EkT}{1-\sigma}$$

$$\text{Hoop stress} = -\frac{\Psi + (1-\sigma)X}{r^2} - \frac{\sigma}{r}\frac{\partial X}{\partial r} - \frac{EkT}{1-\sigma}.$$

(In the above expressions r and z are radial and axial directions respectively, σ is Poisson's ratio, v is the direction at right angles to the boundary,

E is Young's Modulus, k the coefficient of linear expansion, and T temperature.)

These boundary conditions are quite satisfactory for use with the relaxation technique even if the boundaries are very irregular, and a convergent numerical solution is now nearing completion. The thermal stresses can thus be found for any known axially symmetrical state of temperature distribution, varying radially and axially, whether it be transient or steady.

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'Sudden Commencements' in Geomagnetic Field Variations

A STUDY of the phenomenon of 'sudden commencements' in geomagnetic field variations has been made by Newton[1] and also recently by Ferraro and Parkinson[2], but the observations analysed are insufficient to ascribe definite cause and characteristics to this phenomenon. The records of Alibag Observatory (φ = 18·6, λ = 72·9) over the period 1905–44 have been analysed to provide further data. The first type of s.c., characterized by a rise in H and a fall in V, is very prominent in the Alibag records and can be picked up without any difficulty. The second type described by Ferraro and Parkinson, where the increase in H is preceded by a small movement in the opposite direction, is *absent* from the Alibag records. The third type, called the 'inverted s.c.'s', does occur at Alibag, but their frequency is small. It is quite possible that they are not really s.c.'s but form part of normal fluctuations. Altogether, about 800 s.c.'s were recorded during the period under review, of which only 28 can be classified as 'inverted s.c.'s'. In order to fit the curve suggested by Ferraro and Parkinson, the number of s.c.'s of the second type at Alibag (geomagnetic longitude 143·6°) during the period under discussion should have been about 200 instead of the actual figure, 0. This difference is certainly beyond all limits of statistical error and must be a real one. It shows that the suggestion made that the second type of s.c.'s depends upon geomagnetic longitudes is not true, at least in the equatorial regions.

The accompanying graph shows the nature of the diurnal variation of the incidence of s.c.'s at Alibag, for all s.c.'s (curve A) and for those only which are followed by large or moderate disturbances (curve B). They show that there is a minimum between 4h and 7h local mean time and again at about 17h L.M.T., but a maximum between 9h and 13h is more prominent. It is interesting to note that whereas the minima are more pronounced at Greenwich, the maximum is more pronounced at Alibag, and at stations of intermediate latitudes neither of them is pronounced and the frequency curve exhibits no special feature. It may be pointed out here that some of the s.c.'s recorded at one observatory have not been recorded at another observatory. I have given in Table 1 a list of s.c.'s which were recorded very prominently at Alibag but were not recorded at Abinger, and in Table 2 a list of s.c.'s recorded at Abinger but not at Alibag. They show that, although the s.c.'s are possibly a world-wide phenomenon, the data analysed at different observatories are not uniform and are influenced by local effects.

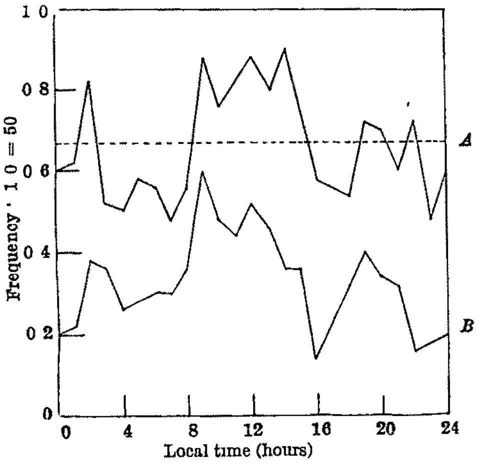

Table 1. SUDDEN COMMENCEMENTS AT ALIBAG BUT NOT AT ABINGER

Date	Time U.T. h m	ΔH for main impulse (γ)	Date	Time U.T. h m	ΔH for main impulse (γ)
1939			1941		
April 23	5 47	84	June 9	9 14	31
1940			Sept 18	4 14	24
March 23	6 18	40	Dec 1	6 00	35
1941			1942		
March 1	5 22	70	March 5	15 22	35
March 30	16 38	44			

Table 2. SUDDEN COMMENCEMENTS AT ABINGER NOT RECORDED AT ALIBAG

Date	Time U.T. h m	Date	Time U.T. h m	Date	Time U.T. h m
1939		1941		1944	
April 19	7 38	July 22	22 56	May 16	12 46
1940		1943		Dec 16	0 28
April 1	16 8	Feb 16	20 56		
Aug 26	2 56	Aug 28	12 56		

The above lists are only a few of the types they represent and have been given so that other observatory records may be examined for these cases to find out, if possible, the nature of the geographical distribution of the s.c.'s which is essential in locating the origin of this interesting type of geomagnetic fluctuation.

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Mechanisms of Excitation of the $C^3\Pi_u$ State of Molecular Nitrogen

IT has been suggested in a previous communication[1] that the mechanism involved in exciting the triplet-levels of molecular nitrogen by electron collision in gaseous electrical discharge, or controlled electron sources, is not, as has been previously assumed, a direct excitation from the lowest vibrational level of the triplet state concerned, but rather an indirect process in which the levels of an upper singlet state (either $a^1\Pi_g$, or one of a group of states between 12 and 15 volts above $X^1\Sigma_g^+$ called 'b' in ref. 1) are first excited Then a second process, presumably a collision of the second kind between the molecule in the excited singlet state and a slow electron, results in a transition to the vibrational level of the triplet state concerned

The particular case of excitation of vibrational levels of the $C^3\Pi_u$ state followed by the subsequent emission of the second positive band system ($C^3\Pi_u \rightarrow B^3\Pi_g$), has been analysed from a kinetic point of view upon the assumption of (i) a direct excitation process ($X^1\Sigma_g^+ \rightarrow C^3\Pi_u$) and (ii) an indirect excitation process $X^1\Sigma_g^+ \rightarrow b \rightarrow C^3\Pi_u$ Comparison of the resulting final equations, of which more complete details will be published shortly, with experimental results, indicates which of the excitation mechanisms is the more probable It is this comparison which is here presented

After considerable simplification, the result of the kinetic analysis of both mechanisms is an equation of the form •

$$\log\left(\frac{I_{CB}}{n_e}\right) = \text{const.} - \frac{\alpha}{T},$$

where I_{CB} is the integrated intensity of a particular band of the second positive system excited in a region of a discharge plasma where the electron concentration is n_e and electron temperature is T $\alpha = \frac{eE_{XC}}{k}$ for the direct mechanism and $\frac{eE_{Xb}}{k}$ for the indirect mechanism, where E_{XC} is the energy separation between $X^1\Sigma_g^+$ and $C^3\Pi_u$—about 11 volts—and E_{Xb} is the energy separation between $X^1\Sigma_g^+$ and 'b'—about 14 volts , e and k have their usual significance

Experiments have been performed, using a simple D C glow discharge in nitrogen as a source of radiation, in which n_e and T can be measured electrically The discharge plasma when focused upon a spectrograph slit allows the second positive band system to be photographed and hence the integrated intensities I_{CB} can be measured. Preliminary results for four of the bands of the second positive system are given in the accompanying table

Band	α	E (electron volts)
(0, 0)	15 4	13 1
(0, 2)	20 1	17 3
(1, 3)	21 6	18 5
(2, 4)	16 5	14 2

It is evident that although no great accuracy at the moment is claimed for the results, they indicate that the energy E involved in excitation of the $C^3\Pi_u$ state is of the order of the separation between the levels 'b' and $X^1\Sigma_g^+$ rather than between the level $C^3\Pi_u$ and $X^1\Sigma_g^+$. This suggests, therefore, that the indirect mechanism of excitation of the triplet levels is more probable than the direct mechanism, at least in so far as glow discharges are concerned Work is continuing on these and other aspects of the method, to increase the accuracy and to obtain data upon other bands

I wish to thank the National Research Council of Canada for interest in, and support of, this and an allied project

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Two-Body Nuclear Interaction, consistent, within the Limits of a Single Configuration, with the Spin and Magnetic Moment of the Ground-States of Lithium-6, Boron-10 and Lithium-7

THE matrix elements of a nuclear interaction of the following kind

$$V_{12} = (V_c C_{12} + V_t S_{12} + V_s M_{12})\varphi(r),$$

with

$$C_{12} = (\vec{\tau}_1 \cdot \vec{\tau}_2)\ \{1/10 + 7/30\ (\vec{\sigma}_1\ \ \vec{\sigma}_2)\}, \qquad \text{(ref 1)}$$

$$S_{12} = \frac{3(\vec{r}\ \ \vec{\sigma}_1)\,(\vec{r}\ \ \vec{\sigma}_2)}{r^2} - (\vec{\sigma}\ \ \vec{\sigma}_2),$$

$$M_{12} = \{(\vec{\sigma}_1 + \vec{\sigma}_2) \cdot [\vec{r}\,\vec{p}]\},$$

$$\vec{r} = \vec{r}_1 - \vec{r}_2,\ \vec{p} = \vec{p}_1 - \vec{p}_2,\ r = |\vec{r}_1 - \vec{r}_2|\ ,\ \varphi(r) = \frac{e^{-r/a}}{r/a},$$

$$a = 1\ 35 \times 10^{-13}\ \text{cm}\ ,$$

have been evaluated for the levels arising from the nuclear s^4p^2(^{6}Li), s^4p^3(^{7}Li) configurations and for the levels of maximum orbital symmetry (partition numbers [42]) of the s^4p^6(^{10}B) configuration, using oscillator wave functions Using the measured magnetic moment of lithium-6 to determine the $S-D$ admixture in its ground-state (neglecting, however, the contribution[2] of M_{12} to this moment), a relationship between V_c, V_t, V_s, is deduced for the consistency with spin 1 for the ground-state of lithium-6 It is found then that there still remains a range of possible values of V_c, V_t, V_s consistent with the spins for the ground-states of both lithium-7 and boron-10 (3/2 and 3 respectively)

Taking $V_t = 1\ 87\ V_c$, $V_s = -0\ 34\ V_c$, V_c positive (values within this small range), one obtains, also, agreement with the magnetic moments of boron-10 and lithium-7, again neglecting the contribution to these moments due to M_{12} It is to be noted that this interaction involves a tensor force of the opposite sign to that usually assumed, although it is not necessarily excluded by experiment[3] No agreement could be obtained with a tensor force of opposite sign, nor with a charged or charge symmetric spin-orbit interaction, although the tensor force may be charged or charge-symmetric The central force can also be modified considerably without affecting the result, for example, it could be neutral or charged. The measured positive quadrupole moment of lithium-7 could not be accounted for

Since the calculations of Present and Feenberg[4] show that by considering inter-configurational mixing, a positive quadrupole moment of lithium-7 may be achieved with purely central forces, it is clearly necessary to extend the above calculations to include inter-configurational mixing before definite conclusions are reached, although appreciable amounts of spin-orbit and tensor force interactions are indicated. It would also appear desirable to investigate whether, with an appreciable spin-orbit interaction present, the deuteron and scattering data are consistent with a tensor force of opposite sign

A detailed description of the method, which makes use of the fractional parentage coefficient method developed by Racah[5], will be published elsewhere.

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[1] Rosenfeld, "Nuclear Forces", 233 (Amsterdam, 1948).

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A Non-Parametric Method of Testing *k* Samples

Pitman[1], Wald and Wolfowitz[2], Dixon[3] and others have suggested non-parametric methods for testing the null-hypothesis of two samples Recently, I have used[4] similar methods for testing k samples The object of the present communication is to show that S of Kendall's[5] τ for rank correlation can be used in testing the null-hypothesis of k samples from univariate populations

Suppose there are k samples of sizes $n_1, n_2, \ldots n_k$ such that $\sum_1^k n_r = n$ Assume that all the observations are different Let $S_{n_1}, S_{n_2}, \ldots S_{n_k}$ be the values of S for the k samples Also let S_n be the value of S for the k samples arranged in a sequence (that is, the samples are put in the order 1, 2, . k as presented for examination). It can be shown that

$$z = \frac{S_n - \sum_1^k S_{n_r}}{\sqrt{v_n - \sum_1^k v_{n_r}}}$$

(where v stands for the expected variance of S) tends to be distributed normally as n tends to infinity

This finding can obviously be used for testing the null-hypothesis of k samples It can also be extended for examining the data of randomized block and Latin square lay-outs

Full details will be published in the *Journal of the Indian Society of Agricultural Statistics*

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Aug 21.

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Bursting Bacteria by Release of Gas Pressure

MANY investigations of bacterial metabolism require that the contents of the cell be released This apparently simple requirement has not yet been met in a completely satisfactory way The present method differs in principle from previous techniques It consists of sudden release of applied gas pressure and is very simple, rapid and inexpensive Under optimum conditions, bursting of well over 90 per cent of the cells is easily attained, and the only substance introduced is a gas which has been shown to be non-injurious to the bacteria

In the present experiment, aviator's oxygen-breathing bottles (surplus), 3,000 lb /in.² test, 350 ml capacity (the small type for parachute jumps), were modified for use There is now available in a variety of sizes a very similar inexpensive bomb constructed of stainless steel and rated at 1,800 lb /in ² (Hoke, Inc , Englewood, N J)

Before introducing the bacteria, the tank is sterilized by rinsing with water and then autoclaving In the present experiments the bomb was kept in a bath at 37–38° The gas, for example, nitrous oxide, is forced into the tank over the course of a half to one minute (to minimize the effect of heating due to the compression of the gas) until the pressure is about 500 lb /in.². The apparatus is then shaken a few times and allowed to stand for about three minutes The pressure regulator is closed, the bomb inverted over a beaker or flask, shaken, and the culture expelled *as rapidly as possible* The excess gas is then bled out slowly to avoid unnecessary dissemination of bacterial spray This entire operation requires less than five minutes If greater breakage is desired, the bomb may be evacuated and the culture put through more cycles of the same treatment.

The efficiency of the procedure was tested by agar plate (viable) counts and by direct microscopic observation of unstained bacteria with the Petroff–Hauser counting chamber.

Bacterial cells are so small that it is most difficult to secure substantial breakage by mechanical methods without such intensive localized friction that heating effects ensue with concomitant likelihood of enzyme denaturation In the present method, actual breaking action comes, presumably, from the expansion of gas within the bacterial cell and hence involves cooling rather than heating, chilled cultures will, in fact, freeze on being expelled The gas introduced does not injure the bacteria so far as has been observed. Preliminary experiments indicate the retention of formic dehydrogenase enzymatic activity (I wish to thank Dr Arthur B Pardee for these determinations), but show destruction of bacteriophage Obviously the method would require adaptation for pathogenic organisms, since considerable spray is produced The present experiments were confined to *Escherichia coli* strain *B* grown with aeration in a synthetic (glycerol, 'Casamino acids') medium

The gas used for this method of bursting should be as inert as possible With carbon dioxide the bursting was successful, but viable counts were always much lower than Petroff–Hauser direct counts, possibly

Table 1 DIRECT MICROSCOPIC AND VIABLE COUNT OF *E coli* BURST BY VARIOUS GASES

Gas	Pressure	Starting concentration (cells/ml)	% Burst (Petroff–Hauser count)	% Rendered non-viable
Nitrogen	900	$1\ 5 \times 10^8$	75	72
Nitrous oxide	500	$1\ 0 \times 10^8$	54	43
	500	$2\ 0 \times 10^8$	61	75
	500	$9\ 2 \times 10^7$	78	76
	500	$2\ 2 \times 10^8$	64	61
Carbon dioxide	500	$1\ 5 \times 10^8$	56	99
	500	$2\ 1 \times 10^8$	57	95
	500	$2\ 5 \times 10^8$	48	96

because the acidity produced in the solution by this gas under 500 lb /in ^{2} pressure may have killed a considerable percentage of the bacteria Using nitrous oxide and nitrogen, however, the plate count (viable count) parallels the microscopic count, that is, no intact cells are non-viable (Table 1) Moreover, it was found that when the culture is released slowly, the bacteria are recovered nearly intact by both viable and Petroff–Hauser counts Nitrous oxide was ineffective at 250 lb pressure, but satisfactory at 500–800 lb The same effect was observed with argon and nitrogen, which require pressures of 900 lb or more for bursting (Table 2) It is thought that the relative inefficiency of these gases may be related to their low solubility.

Table 2 BURSTING OF *E coli* WITH VARIOUS GASES
The figures represent the range observed in two or more experiments under the same conditions (20-ml sample in bomb 3 min)

Gas	Pressure	Starting concentration (cells/ml)	% Burst (Petroff–Hauser count)
Argon	500	3 0–4 5 × 10^8	0–7
	900	2 8–6 0 × 10^8	30–46
Nitrogen	500	2 8–3 3 × 10^8	14–20
	900	1 1–1 5 × 10^8	75
Nitrous oxide	250	1 0–1 9 × 10^8	0–5
	500	1 0–2 2 × 10^8	54–78
	750	1 1 × 10^8	53–56
Carbon dioxide	500	1 5–2 5 × 10^8	48–56

Considerable investigation of the range of conditions has shown that by far the most important factor is the speed with which the culture is released The best results were obtained when the culture was released as rapidly as was consistent with the recovery of the sample Expelling the culture through fine orifices (0 0135 in and 0 004 in diameter) gave no substantial breakage

In a bomb of volume 350 ml it has been found that the efficiency drops markedly with sample volumes greater than 50 ml

The experiments were done usually at a bacterial concentration of 10^8/ml For most purposes, it is customary to raise bacteria to saturation—that is, a 24-hr culture When such resting phase *coli* were used, however, the breaking by gas release was in every case highly inefficient For the present it seems that the bacteria should be harvested just before the end of logarithmic growth, that is, *c.* 10^9 under present conditions Results of several successive bursts indicate that with 10^8 bacteria/ml , greater than 90 per cent breakage can be secured in two bursts, and even higher percentages of breakage can be obtained by further bursting cycles Post-logarithmic (24-hr) cultures showed very poor initial bursting and the percentage was not improved appreciably by repeated cycles Cells concentrated by centrifugation are burst, but less efficiently than log-phase cultures

Recoveries even of small samples (10–20 ml) are surprisingly good considering the nature of the process Despite the apparent amount of spray produced, usually only 3–4 ml were lost

This work was carried out under a fellowship of the American Cancer Society recommended by the Committee on Growth of the National Research Council

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Significance of 'Fungus Gardens' in Termite Nests

THE significance of the 'fungus gardens' found in the nests of termites of the family Termitidæ is uncertain It has been supposed that the fungi are used as food , but Grassé[1] has shown that the conidia and the mycelium cannot be of great food value for a big colony, although the presence of the remains of conidia in the alimentary canal proves that they are sometimes eaten by the workers The 'fungus gardens' may also take part in maintaining a suitable humidity[2]. In those species in which the brood is found in the 'fungus gardens', it has been thought that the 'gardens' form a suitable milieu for the delicate larvæ But as the brood may also be found (sometimes in the same species) elsewhere in the nest, this function has not been clearly demonstrated The following observations made during an expedition of the Swiss Tropical Institute to East Africa in 1949 may throw new light on this problem

Role of the fungi as food Although the conidia are undoubtedly eaten (see above), it appears that workers have never been observed in the act of consuming them The shape of the typical spherical conidia ('cauliflowers') was formerly supposed to be dependent upon the termite activity, but it is now clear that *Termitomyces* also produces the same conidia in artificial culture[3] Using a method recently described[4], it was possible to keep a colony of about two thousand individuals of *Synacanthotermes zanzibarensis* Sjostedt (kindly identified for me by Prof A E Emerson, of Chicago) under observation for a period of two months The artificial nest contained several fragments of 'fungus garden' which were enlarged by the termites during the course of the observation These were covered with mycelium and conidia The termites never appeared to attack the mycelium The conidia also generally remained immune from attack But on two occasions conidia were eaten After having been attacked by one worker, other workers which were passing near by were suddenly attracted and began to gnaw at the conidium Sometimes four or five workers would be thus occupied, and the conidium was then completely destroyed within twenty minutes Apart from these, no other conidia were attacked while the colony was under observation

We may conclude that the conidia are immune for a long period , but that they are sometimes suddenly attacked and then eaten completely within a very short time, probably after having reached a certain degree of ripeness This may explain why the actual process of devouring the conidia has never been observed previously, and also why partly destroyed conidia are never found in the 'fungus gardens' They are attacked so rarely that they can scarcely play a large part in the nutrition of the termites, though they may possibly serve as a source of vitamins, as Grassé has supposed[5]

Production of heat by 'fungus gardens' 'Fungus gardens' of *Macrotermes bellicosus* Smeathman, together with the brood and workers, were collected and placed in a 4-gallon can which was about three-quarters filled After about four hours, the temperature in the container had risen to 35° C while the surrounding temperature was 26° C Early next morning the temperature was 40 5° C and room temperature 21° C This shows that there are probably fermentation processes going on in the 'fungus gardens' which lead to the production of heat The unnatural agglomeration of the 'gardens' in the can generated an exceedingly high temperature

I then carried out some temperature measurements in a mound of the same species The following measurements were made on October 11, 1949, in Ifakara (Tanganyika Territory) in the shade

Site of temp measurement	9 a m	4 p m
Air temperature	27° C	31° C
Surface of soil	27	32
Soil 4 cm deep	25	29
,, 12 ,, ,,	25	26 5
,, 20 ,, ,,	25 5	26
Mound surface	27	31 5
,, 6 cm deep (wall)	27	29
,, 10 ,, ,, ,,	28	28
,, 16 ,, ,, ,,	29	29
,, 20 ,, 'fungus gardens'	30	30
,, 28 ,, ,, ,,	30 5	30

The relative humidity in the wall was about 85 per cent, in the 'fungus garden' area 95 per cent. The temperature in the interior of the nest where the 'fungus gardens' lie scattered is always about 30° C. and remains very constant, at least in mounds standing in the shade of trees In mounds exposed to the sun, the temperature in this region may rise by 2–3° C in the afternoon

These observations indicate that the 'fungus gardens' play a large part in conditioning the microclimate of the nest cavity of termite mounds. They not only maintain a constantly high humidity, which may be brought about by the metabolism of the fungi, but they also produce heat and play their part in maintaining a constant high temperature in the nest cavity We suppose that this heat production is brought about by the activity of bacteria which may also be present in the "fungus gardens without fungi" found by Grassé and Noirot in the nests of *Sphærotermes sphærothorax* Sjostedt[6]

I wish to thank Prof R Geigy, director of the Swiss Tropical Institute, for making possible my participation in the Swiss East Africa expedition

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July 30

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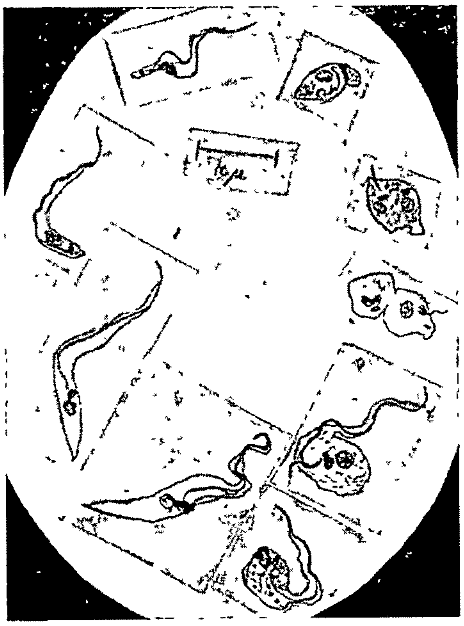
Occurrence of a Trypanosome in *Triatoma rubrofasciatus* in Calcutta

The occurrence of a trypanosome as a parasite in a triatoma has hitherto escaped notice in India In 1909 Donovan, however, reported the presence of crithidia in the intestines of *Triatoma rubrofasciatus* in Madras *Triatoma rubrofasciatus*, the common Indian cone-nosed bug, is found almost exclusively in and near human habitations It is usually active at night, frequently feeding on human blood.

Of forty-five specimens collected from different parts of Calcutta and examined, thirty-six adult nsects and nymphs harboured in their guts a large number of trypanosomes in various stages of development



For the purpose of observation each insect was treated in the following manner The entire alimentary canal with the salivary glands was carefully dissected out Smears were taken from (*a*) teased salivary glands and the œsophagus, (*b*) mid and upper part of the lower intestines, (*c*) lower intestine containing the fæcal matter, and (*d*) the hæmocœle fluid

All the smears were stained with combined Leishman and Giemsa stains and examined It was found that (i) the hæmocœle fluid and the salivary glands and œsophagus revealed no parasites, (ii) the mid and lower sections of the intestine contained developmental forms of trypanosomes, (iii) the fæcal matter from the lower part of the intestines and the rectum contained only crithidia and trypanosomes

The accompanying illustration is from a camera lucida drawing of the parasites

As illustrated, the trypanosome is long and slender, often C-shaped, the posterior end tapering sharply to a point The width of the undulating membrane is variable, being very narrow in the young forms The nucleus is oval in shape, and it lies nearer the posterior end The parabasal body is somewhat elongated and the flagellum is rather small

Measurements

	Average	Range
Length of the body	23 μ	20–27 μ
Length of the flagellum	11 μ	10–12 μ
Total length	34 μ	30–39 μ
Width of the body at nucleus	5 μ	4 9–5 3μ
Diameter of the nucleus	2 7 μ	2 4–3 3 μ
Distance of the nucleus from the posterior end	10 2 μ	9–11 6 μ
Distance between the nucleus and the parabasal body	4 2 μ	3 3–5 3 μ
Width of the undulating membrane	2 2 μ	2 1–2 4 μ

Further work on the subject is in progress

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Influence of Shoot Apex on Subjacent Shoots of *Lupinus albus* L.

THE importance of the shoot apex in the origin of tissues of the primary shoot is emphasized by numerous recent developmental studies (see review by Philipson[1]). The suggestion was made by Bower[2] that there is a "proleptic" sensitiveness of the tip to the incidence of similarity which would determine a stelar structure suitable to the size ultimately to be attained. Dixon[3] thought that the already differentiated procambium might precipitate procambium from the undifferentiated meristem.

The idea of control of the morphogenetic activity of the shoot apex by the subjacent, mature tissues was further utilized in studies of *Linum* by Esau[4], of *Sequoia* by Sterling[5], of *Ginkgo* by Gunckel and Wetmore[6], where the procambium was described as differentiating acropetally into the shoot apex into a position that would later have been the site of a foliar primordium. Ball[7] described a different relationship in *Lupinus albus*: a suspended strand of procambium that was produced in conjunction with the foliar primordium. Snow and Snow[8–10] demonstrated that it was possible to change the positions of future foliar primordia on the apex of this plant and of *Epilobium hirsutum* by longitudinal splits. The leaves produced after these operations appeared (from the illustrations given) to have normal vascular systems; it can be suggested that the shoot apices produced procambium in the positions appropriate to the new locations of the foliar primordia. It would seem, therefore, that in these plants the leaf determines the position of the procambium, and not vice versa. Snow and Snow[11] later demonstrated that undercutting the presumptive area of the second future leaf on the shoot apex of *L. albus* caused an interruption in the central strand of that leaf, but did not prevent the approximately normal development of the leaf. They concluded that leaf traces and the tissues from which leaf traces will be formed play no appreciable part in determining the positions of the leaves. The development and maturation of the subjacent shoots after the operations were not described by Snow and Snow.

This matter has particularly interested me, and suitable material for such studies was obtained after removing the central initials of the shoot apex of *L. albus* (Fig. 1). The lateral remains of the shoot apex frequently regenerated two normal apices—one on each side of the operation (Fig. 2). These new shoot apices then grew and left behind tissues that differentiated into two approximately normal shoots. The vascular systems of these new shoots appeared, in serial transections, to have been deposited on top of the previously existing procambial system. By following the illustrations, Figs. 3–24 (serial transverse sections of a shoot system sixty days after the operation on the shoot apex), it can be seen that a single ring of bundles gradually changed into two rings of bundles, each of which constituted the vascular system of a separate shoot. All these major

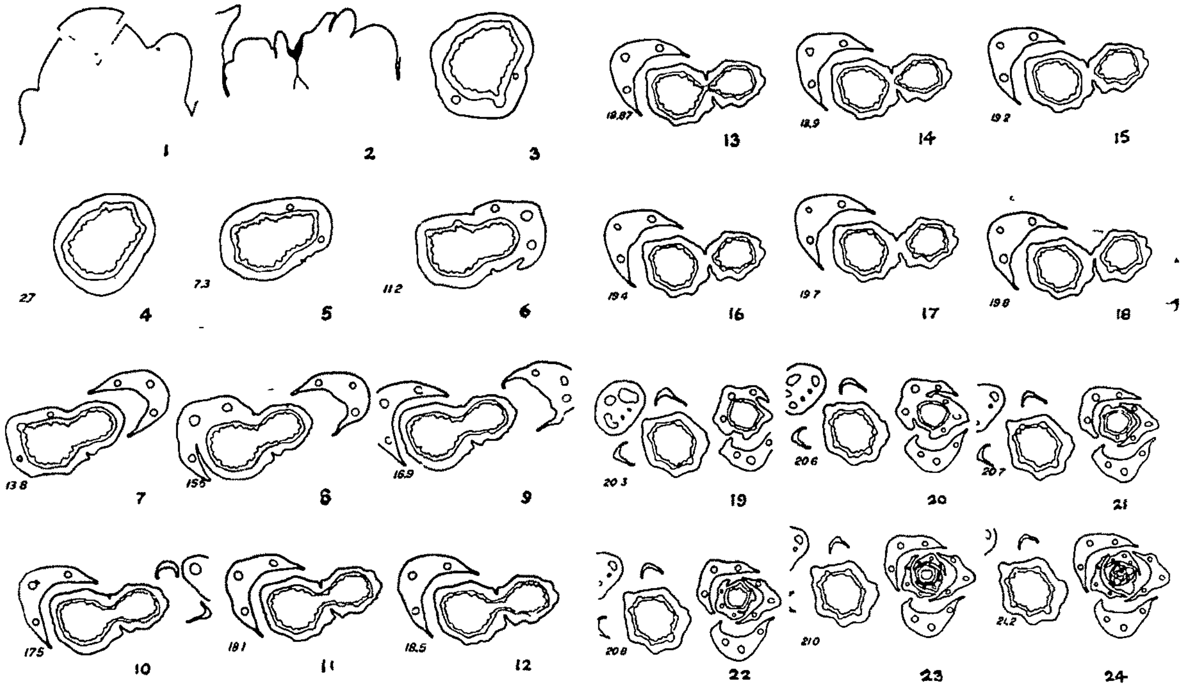

Fig. 1. Longisectional diagram of the shoot apex showing the central sector that was removed in the operations. × 68

Fig. 2. Longisectional diagram of the two regenerated apices 18 days after the operation. If these apices had been allowed to grow, they would have developed into a two-shoot system on top of the original shoot, as shown in the succeeding figures. × 26

Fig. 3. Transection of uppermost part of shoot present before the operation. Normal anatomy is shown. × 3.6

Fig. 4. Transection of stem 2.7 mm above Fig. 3, showing slight flattening due to formation of subjacent tissues by both regenerated apices. × 3.6

Fig. 5. Transection of stem 7.3 mm above Fig. 3, showing further flattening. × 3.6

Fig. 6. Transection 11.2 mm above Fig. 3. Stem is flat and the separate rings of bundles produced by the two regenerated apices are beginning to be evident. × 3.6

Figs. 7–13 show the appearance of constrictions on both sides of the flattened stem, with the result that the flat ring of bundles is seen to change gradually into two almost separate rings, each of which has been produced by one of the regenerated apices. Fig. 12 has the number of bundles appropriate to two normal shoots. × 3.6

Figs. 14–18 show the gradual separation of the two shoots until they are held together only by a narrow band of cortex. The number of bundles in each shoot is appropriate to a normal shoot. × 3.6

Figs. 19–24 show the transectional series up through the level of the shoot apex of the right shoot, 21.2 mm above Fig. 3. (The level of the shoot apex of the left shoot is approximately 1 cm above that of the right shoot, and is not shown.) × 3.6

changes in the ontogeny of this plant were brought about by an operation upon the shoot apex

The results of this experiment can be considered evidence that the shoot apex produces, and has a determining effect upon, the differentiation of the subjacent tissues of the primary shoot in this plant

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Cytology of *Polypodium* in America

IN two recent publications[1,2] on the cytogenetics of "*Polypodium vulgare*" the situation in Europe has been made fairly clear There are three distinct species (perhaps ecospecies), one of which, the hexaploid, is probably of local origin and compounded of the other two, which are diploid and tetraploid respectively The tetraploid, which covers northern Europe, is not closely related to the diploid, which has a more restricted and southerly range, and its origin must probably be looked for farther east, perhaps in Asia, in some birthplace or refuge area from which it has spread over the heavily glaciated countries of northern and central Europe

Since *P vulgare* in the wide sense is circumpolar in distribution with only a few significant gaps, information about non-European populations is essential to an understanding of it In 1948, when the manuscript for the most recent statement[2] was actually compiled, only enough was known about these to indicate that the ancestral stocks must have spread over much, if not all, of their circumpolar range in the diploid condition, for Canadian material from both sides of the American continent had been found to be still in this state A good deal of further information has since come to hand in the two years during which that statement was passing through the press, and the purpose of this note is to bring the published information more nearly up to date in the hope, among other things, of stimulating the interest of collectors to send additional samples of living material

In the North American continent as a whole, "*P vulgare*" occurs on both sides, though it is absent from the centre On the eastern seaboard the sole representative is *P virginianum*, a well-defined taxonomic species superficially resembling the European tetraploid, though diploid in constitution and undoubtedly specifically distinct On the north-west of the continent, forms superficially resembling the diploid of Europe have sometimes been referred to[2,3] as *P vulgare* var *occidentale*, while in California there are numerous types, perhaps including these, which are variously split up into taxonomic species[4] under the names of *P glycyrhiza*, *P hesperium*, *P californicum* and *P Scouleri*

Largely by the kindness of my colleague, Dr H G Baker, and other correspondents, some material of all of these has been examined cytologically, together with one additional specimen from Hawaii The results are as follows

1	*P pellucidum* Klf	Hawaii	Diploid
2	*P virginianum*	Nova Scotia	Diploid[2]
	,, ,,	Ontario	Diploid
3	*P vulgare* var *occidentale* (= *P glycyrhiza*)	Vancouver Island	Diploid[2]
	,, ,,	Canadian Rockies	Diploid[2]
4	*P glycyrhiza*	Mill Valley, California	Diploid
5	*P hesperium*	Columbia River, Oregon	Diploid
6	*P californicum*	near Portola California	Tetraploid
	,,	Searsville Lake, California	Tetraploid
7	"*P Scouleri*" three plants from Point Reyes, California, with different degrees of fleshy leaves All showed hybrid meiosis Two plants triploid and one diploid		

One of the more striking facts which emerges from this list is the apparently tetraploid nature of *P californicum* among a prevailing population of diploids The hybrid swarm inhabiting Point Reyes is also of interest, although it precludes a successful diagnosis of the cytological status of *P Scouleri* until purer material is to hand Among the two triploids listed under 7, the leaves of one had the coriaceous character of *P Scouleri* in an extreme degree though the leaves of the other were softer Both showed *n* pairs and *n* univalents at meiosis This contrasts strikingly with triploids found in Europe, in which practically all the chromosomes had remained unpaired[2] This suggests that there are at least some tetraploids in California which are closer genetically to local diploids than is the case in Europe

This problem is being further investigated by genetical means in Leeds

While the most outstanding need from America is the provision of a purer sample of *P Scouleri*, further samples of any species, especially from parts of the continent such as Baja California, which have not yet been represented, would be very welcome At the same time, the importance of acquiring some knowledge of the state of affairs in Asia for interpretation of both the other continents is becoming increasingly obvious In addition to Europe and Asia, "*P vulgare*" is known to occur not only deeply into the heart of Russia but also, after a gap in central China, on the Pacific seaboard in eastern China, Korea and Japan While it is obvious that under present conditions free collecting in any of these areas is out of the question, even one specimen from one of these localities would illumine to a unique degree the history of floras in the whole of the northern hemisphere

I would be extremely glad to receive any additional samples of known wild origin from overseas, relevant to this problem An ideal wrapping material for the rhizome of a live plant is the waxed paper lining of a 'corn flakes' packet, in which it can be slipped into an ordinary envelope and dispatched by letter post Where available, air mail is to be preferred, but these plants are usually very hardy and can survive up to three weeks postal period if suitably wrapped From very remote areas a fertile frond in a folded paper would suffice, though there is always a risk with spores that germination may fail In all cases, exact details of the place of origin should be included, and all postal expenses will be gladly refunded to the sender if a name and address is enclosed

I MANTON

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Stylonichia mytilus and the Lunar Periods

During a recent investigation at the University Botany School, Cambridge, of the association of ciliate protozoa and bacteria in a chalk stream, *Stylonichia mytilus* in common with other ciliate protozoa exhibited a series of 'pulses', or maximum waves when it spread down the stream, and minimum phases when it could be found only in the upper reaches. Forms in binary fission or conjugation were sometimes noted at the end of the maximum phase, whereas the minimum phase was generally marked by the appearance of small forms. The pulse of *Stylonichia* could not be related to any constant climatic or physical factor (rainfall, *p*H, temperature, etc.) or to total bacterial numbers at 22° C. or any particular group of bacteria. However, the maximum phase often occurred about a week to ten days after one of the lunar periods. From May to December 1947, the maximum phases occurred on twelve out of thirteen occasions a week to ten days after a new moon or a full moon: the greatest maximum peak was attained nine days after a new moon in July and four days after a full moon in December. By contrast with the dry weather and clear nights of 1947, the year 1948 was wet and dull. *Stylonichia* was only recorded between May and September, yet on five occasions it reached its maximum phase on an average eight days after a new or a full moon.

In the inquiry, samples for protozoological examination were always withdrawn from the stream opposite twelve fixed points, and an arbitrary estimation made of the numbers in not less than six drops of uniform size. A statistical analysis was made of the apparent association between *Stylonichia* and the lunar periods, and of its association with the full moon, as this was regarded as of particular interest, by the Statistical Laboratory of this University. The arbitrary numbers of *Stylonichia* were considered in relation to the lunar periodicity in days, and the report of the analysis was as follows: "The observations were classified according to the number of days after the full moon when they were made. Assuming the counts to be distributed in a Poisson distribution a χ^2 test was applied to see if the Poisson means were the same at all phases of the moon. In order to make the test valid, it was necessary to group the observations into sets of four days; the mean counts for each group were as follows:

Days after full moon	0–3	4–7	8–11	12–15	16–19	20–23	24–27	28–30
Mean count	0·5	2·0	1·0	1·0	0·7	1·0	1·8	0·5
No. of observations	4	6	3	5	3	5	5	2

"The value of χ^2 was 8·42 on 6 degrees of freedom, not significant. However, when the data were grouped by the number of days to the *nearest*, not the *last*, full moon, $\chi^2 = 8·15$ was obtained on 2 degrees of freedom, significant at 5 per cent. This suggests that *Stylonichia mytilus* has a maximum about 4–7 days before and after a full moon, with slight evidence for a drop at the full moon itself. These statements will require more data before they can be made conclusive."

While fully agreeing with the last statement, the statistical analysis was not made until 1949, a year after the inquiry was completed, and it is perhaps remarkable that so suggestive a decision was reached on field-observations made with quite a different object in view. Alone, the observation might not be of so much interest were it not that *Stylonichia mytilus* is a diatom-eating ciliate and there is an abundant phytoplankton of diatoms in the stream concerned, which is swift, cold and shallow. Kofoid[1], in a statistical analysis of the phytoplankton of the Illinois River, records an association between the pulse of Bacillariæ (that is, diatoms) and the lunar periods. He states that the average lag of the phytoplankton pulse after the full moon was 13·7 and 14·8 days respectively and that the correlation of full moon and maximum phase of diatoms was most intimate in the stable conditions of summer when the average of the average monthly lags for all the May–August pulses was 11·9 days. In the absence of other information, it was assumed that in the particular stream examined the *Stylonichia* were following a lunar periodicity of diatoms (on which they fed) similar to that described by Kofoid in the Illinois. Maximum phases of the ciliate might follow therefore maximum phases of the diatoms, succeeded by periods of reproductive activity.

I wish to express my thanks to Mr. D. V. Lindley, who made the above statistical analysis.

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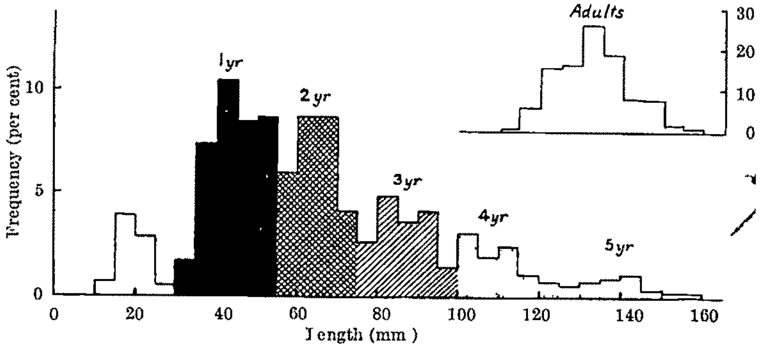
Duration of the Larval Period in the Brook Lamprey (*Lampetra planeri*)

Although the question of growth and the duration of the larval period in the brook lampreys has received considerable attention, the conclusions reached have been indecisive. In these animals, which spend the whole of their life in fresh-water, the problem is simplified in so far as the growth period ends at metamorphosis with the closure of the fore-gut and the cessation of feeding. Sexual maturity is reached in the first spring following metamorphosis, when the adult spawns and dies.

The most complete of recent work on this subject is that of Knowles[1] in Italy, Schultze[2] in Michigan and Ivanova-Berg[3] in the Gulf of Finland. Estimates of the total life-span as given by these authors are three, three to four and five years respectively. For *L. planeri* in the British Isles, the only similar study, so far as is known, is my own[4], based on collections of larvæ and adults from streams in Somerset. The con-



clusion then reached from a study of the frequency curves was that metamorphosis probably occurred when the ammocœte was three and a half to four and a half years old, giving a total life-span of four to five years. It was remarked, however, that both the rate of growth and the size of the adult vary considerably from one stream to another and even in different localities on the course of the same stream, so that conclusive results could only be expected if larvæ and adults are collected from a restricted area of a single stream.

Since my previous work, collections have been made in a restricted stretch of the River Yeo in Somerset, and from the additional data so obtained it would appear that the larval period for the population of this stream was under-estimated. The new material consists of the recorded lengths of 606 ammocœtes collected in June, July and August 1947–50 and 209 adults caught in April 1947 and 1950.

Length-frequency curves plotted for separate monthly collections indicate five yearly classes. The curve for the total material is reproduced in the accompanying histogram, with length-groups of 5 mm. and frequencies expressed as percentages. The first group, 10–30 mm., with a peak at 15–20 mm., consists of the youngest larvæ hatched during the spring of the current year. Further well-defined groups occur at 30–55, 55–75, 75–100 and 100–125 mm. with mean lengths estimated as about 40–45, 65, 85–90 and 105–110 mm., respectively. These groups represent ammocœtes in their second, third, fourth and fifth summers of growth. Over the remainder of the curve the number of specimens represented is small, but there is some indication of a further group at 125–160 mm. with a mean about 140–145 mm. That portion of the frequency curve from 100 mm. to 160 mm. would in any event be unlikely to consist of a single age-group, when consideration is given to the smaller dispersion of the adult frequency-curve, which extends from 110 mm. to 160 mm. with a mean of 133 mm. Moreover, allowance must be made for a reduction in length at sexual maturity[4,5], so that the fully grown ammocœtes would have an average length rather greater than that of the spawning adult. This condition is satisfied by the assumption that the part of the frequency-curve between 125 mm. to 160 mm. represents the mature larvæ.

It seems, therefore, safe to conclude that the larval period in this stream lasts more than five years, while the total life-span is exactly six years. Annual increments of growth in length will, on this interpretation, be very uniform, from 20 mm. to 30 mm., the greatest rate of growth occurring during the first and last years of larval life. This new information will make necessary a revision of conclusions previously arrived at regarding the larval period in other streams. It is hoped to publish elsewhere a more detailed re-examination of this question.

I should like to acknowledge my indebtedness to Mr. J. R. O'Connor for help with the collection of material.

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Blood Coagulation: its Prolongation in Vessels with Negatively Charged Surfaces

THE clotting time of blood has for many years been known to depend upon the nature of the surface of the vessel in which it is contained. Freund[1] discovered that the coating of vessels with paraffin wax or with 'Vaseline' markedly delayed the clotting time of blood. Since that time there have been several reports of surface linings more effective in preserving blood, or more convenient to handle than paraffin wax. For example, collodion surfaces were advocated by Hirschboeck[2] and silicone by Jaques[3] *et al.* All attempts to produce new surface linings for the preservation of blood appear to have been based on the idea that the ideal surface would be water-repellent. A surface lining which is not water-repellent and which is suitable for the preservation of blood in a fluid condition for long periods is that of the vascular system. An alternative approach to the problem appeared, therefore, to be found in the preparation of synthetic surfaces resembling in structure the surface of blood vessels.

It is generally believed that the lining of the vascular system is composed of acidic polysaccharide material, for example, mucoitin. It is relatively simple to prepare artificial surfaces having similar physical and chemical properties to those of the natural polysaccharide sulphates. Polystyrene sodium sulphonate has been found to provide the most convenient artificial surface of this type. Its preparation and experiments illustrating its anticoagulant properties are described here.

The surfaces of small polystyrene test tubes were sulphonated by immersion for one minute at 100° C. in sulphuric acid containing 1 per cent silver sulphate[4]. Excess acid and silver salts were removed by washing in ammonia, and soluble polystyrene sulphonate by prolonged washing with dilute sodium bicarbonate. Human blood was collected by venipuncture, using a cold dry syringe, and transferred immediately to the sulphonated polystyrene tubes. The blood was also transferred to untreated polystyrene tubes and glass tubes of similar dimensions to the sulphonated tubes. The tubes were maintained at 20° C. and observed continuously until clotting occurred. The results of these tests are shown in the accompanying table; it can be seen that coagulation is slower in the hydrophilic sulphonated polystyrene tubes than in the water-repellent untreated polystyrene tubes.

COAGULATION TIME OF HUMAN BLOOD IN GLASS, POLYSTYRENE AND SULPHONATED POLYSTYRENE TUBES

Surface	Number of tubes tested	Coagulation time (min.)	Standard deviation of mean coagulation time
Glass	12	9.1	1.7
Polystyrene	16	29.3	10.1
Sulphonated polystyrene	28	41.5	15.3

In some of the experiments just described, a portion of the blood was removed from the sulphonated polystyrene tubes after 15 min. and transferred to glass tubes; clotting always occurred within three minutes of the transfer. The purpose of this test was to demonstrate that the preservation of the blood in the sulphonated tubes was not due to the dissolution from the surface of an anticoagulant, or to the adsorption of some component of the blood necessary for coagulation.

The observation that blood will remain fluid but unaltered when in contact with a highly negatively charged surface suggests a possible explanation of continued fluidity of blood in the normal vascular system , the lining of the latter is similar physically to that of the sulphonated polystyrene tubes

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Oct 13

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Amino-acid Composition of Thymus Histone

In the course of our work on the chemistry of the constituents of the cell nucleus, nucleoprotein has been extracted from cell nuclei of normal and tumour tissue and fractionated into three main components nucleic acid, the basic 'histone' protein and an acid-insoluble protein residue[1] Quantitative amino-acid analyses are being carried out on these fractions It was thought that the results obtained for calf thymus histone would be of value, since the results hitherto available account for only 50 per cent of the total composition[2]

The original nucleoprotein was extracted from the tissue using 1 M sodium chloride as described by Mirsky and Pollister[1] The histone was extracted from the whole nucleoprotein with 0 05–0 1 M hydrochloric acid, and after dialysing the extract the histone was precipitated with ammonia It was redissolved, dialysed and reprecipitated several times. Finally, after thorough dialysis against distilled water, it was freeze-dried For analysis the protein was hydrolysed under reflux with 6 N hydrochloric acid for 16 hr

Analysis of Thymus Histone
(Amino-acid nitrogen as percentage of total nitrogen)

Alanine	6 0	Leucine	3 05
Ammonia	4 8	Lysine	10 8
Arginine	30 7	Phenylalanine	1 9
Aspartic acid	3 3	Proline	2 7
Glutamic acid	2 25	Serine	3 45
Glycine	5 2	Threonine	3 1
Histidine	4 0	Tyrosine	1 4
*iso*Leucine	12 0	Valine	4 9
		Nitrogen recovery	99 5 per cent

The accompanying table shows the results obtained by quantitative analysis, using chromatography on starch columns as described by Moore and Stein[3], of the histone from calf thymus

The results have been corrected for decomposition of threonine and serine according to the data of Rees[4], and indicate that a 'recovery' of nearly 100 per cent has been obtained The presence of the above components (fifteen amino-acids and ammonia) was also established qualitatively by paper chromatography, which also served to confirm the identity of the respective constituents in the separate fractions in the quantitative analysis Davidson and Lawrie[5] reported the presence of thirteen amino-acids in thymus histone, one of which was not identified

The presence of threonine in histone is reported for the first time in the results given above, and Kossel's observation[6] that histidine is a constituent is confirmed An independent estimation of the tryptophane by a colorimetric method gave a very low content of 0 04 per cent No cystine or cysteine could be detected polarographically in the protein

This and other related work will be presented in greater detail in the future The work is part of the research programme of the Birmingham Branch of the British Empire Cancer Campaign

D Hamer*

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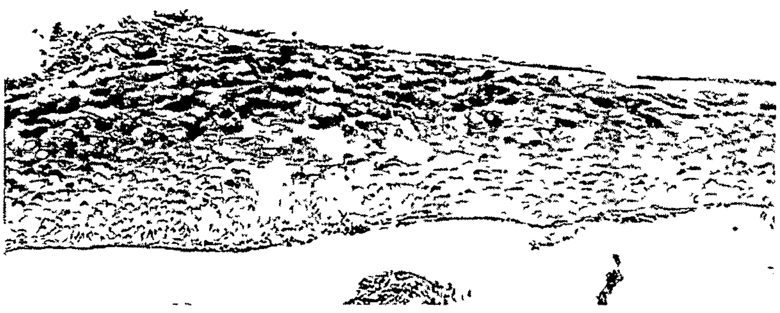
Glycogen of Vertebrate Epidermis

Claude Bernard, in 1859, described the abundant glycogen in the embryonic epidermis of several mammals (pig, cow and sheep)[1] and, in his last course of lectures[2], integrated these observations with the rest of his extensive studies on the histochemistry of glycogen Later during the nineteenth century, the glycogen of embryonic epidermis was studied in some detail[3], but there appears to have been little recent work on this phenomenon, the significance of which remains unexplained

In experiments designed to investigate the very different mucopolysaccharides of the dermis[4], in healing wounds of adult guinea pigs, we noted incidentally the abundance of glycogen in the regenerating epidermis Details of these experiments (carried out during 1948) will be published elsewhere, but there is little doubt that, in animal tissues, glycogen is detected specifically by the histochemical method which was used (the alcoholic periodate-fuchsin stain[5], in conjunction with carefully controlled amylase digestion)

In undamaged epidermis, glycogen is absent, or present only in traces, after chemical fixation (ice-cold, non-aqueous fixative and thin slices of tissue) Undamaged epidermis prepared by freeze-drying contains slightly more glycogen, but still very little[6]



The regenerating epidermis of a mid-dorsal skin wound in a guinea pig, ten days afte operation The epidermis has separated both from the overlying scab and the underlying dermis Glycogen (represented here by diffuse darkening of the cytoplasm) is absent from the 2–3 basa cell-layers, but very abundant in the outer half of the epidermis, particularly in the centr of the wound (left side of photomicrograph) Round the periphery (right), the glycogen concentration is already diminishing as the new stratum corneum is completed

On the other hand, glycogen is abundant in the regenerating epidermis (see photograph) as soon as the latter appears and begins to spread over the wound between the thick scab and the underlying dermal connective tissue Glycogen is never present in stainable quantities in the two or three basal cell-layers of the epidermis, adjacent to the dermis, but is abundant throughout the rest of the new epidermis. About seven days after the wounding operation, the new epithelium completely covers the circular wound, and a new cornified layer of dead, flattened cells begins to form superficially, progressing from the periphery toward the centre and reducing epidermal thickness over the wound from 10–12 cell-layers down to the 4–5 cell-layers found in the adjacent undamaged skin As the outermost cells keratinize, they lose their glycogen Finally, when the scab sloughs off (about fourteen days after wounding), glycogen content throughout the new epidermis has diminished to the level present in undamaged skin, that is, it can no longer be stained after chemical fixation, or appears only spasmodically in isolated cells of the stratum spinosum

Glycogen appears in stainable quantities in a wide variety of tissue environments Its metabolic significance is fairly well understood in some of these sites—for example, muscle, liver and regions of calcium phosphate deposition[7]—but quite unknown in others The main synthetic process occurring in the outer layers of regenerating epidermis is synthesis of keratin Yet many sites of active protein synthesis contain very little glycogen (pancreas, fibroblasts, silk glands[4]) It seems at present that the most probable explanation of this peculiarity of the epidermis lies in its poor supply of glucose and oxygen, since the layer of new epidermis 10–12 cells thick is devoid of blood vessels (and of dermal villi) and is covered by a thick scab Of the various pathways of internal respiration which supply energy for chemical synthesis, those requiring oxygen are therefore likely to be blocked and the cells thrown back on to anaerobic glycolysis—a process yielding much less energy per molecule of glucose used than is liberated during the complete aerobic breakdown of glucose to carbon dioxide For a given amount of protein synthesis, the epidermal cells will therefore require abnormally large quantities of glucose, but here again the absence of epidermal blood vessels must pose serious difficulties, in spite of the special intercellular spaces in the stratum spinosum Hence it is not surprising to find that, as soon as the cells leave the basal layers of the epidermis and commence their outward migration to the surface, they store large reserves of glycogen, which are later used to supply energy for protein synthesis, and are finally exhausted as the cells become transformed into dead, keratinized plaques It would be interesting to know whether glycogen is similarly abundant in the middle and outer layers in other cases where vertebrate epidermis effects rapid keratin synthesis—particularly during the moulting of reptile epidermis, where the stratification closely resembles that of mammalian epidermis[8] It is significant that so long as the cells are situated in the basal epidermal layers, separated only by basement membrane from the vascularized dermis, they never contain demonstrable amounts of glycogen

Most striking among the examples described by Claude Bernard is the hoof of the embryonic cow, which shows clearly how the abundant glycogen of the soft inner layers disappears from each cell as the latter becomes keratinized and added on to the outer, horny layer of the hoof He suggested tentatively that glycogen might actually be incorporated as such into the keratinized tissue[1,2], but it now seems more likely that the explanation is similar to that proposed above regarding the behaviour of glycogen in the regenerating epidermis of skin wounds, namely, the absence of blood vessels in the epidermis results in a poor supply of glucose and oxygen, and, just as the scab excludes atmospheric oxygen, so the developing hoof hinders what little oxygen might diffuse in from neighbouring placental tissue Hence abundant intracellular supplies of glycogen are necessary to support the anaerobic glycolysis imposed on the epidermal cells, and this glycogen disappears as it is used to supply the energy for keratin synthesis, so that the outermost layers of skin and hoof no longer contain appreciable amounts of this substance

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Sept 12

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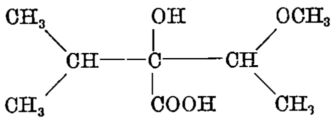
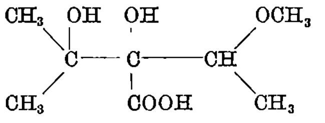
Structure of Lasiocarpic Acid

In view of recent publications[1,2] dealing with the structures of the esterifying acids of the pyrrolizidine group of alkaloids, it seems desirable to place on record the following data relating to lasiocarpic acid obtained from the alkaloid lasiocarpine. Lasiocarpine, together with heliotrine, was first isolated by Men'shikov[3] from *Heliotropium lasiocarpum* F and M Later, Trautner and Neufeld[4] obtained lasiocarpine from *H europæum* L growing in Australia and found it to be accompanied by *iso*heliotrine, a base differing from Men'shikov's heliotrine only in respect of its optical rotation Trautner and Neufeld's work has been repeated and confirmed except for the yields of the two alkaloids Lasiocarpine from *H europæum* is clearly identical with the alkaloid from *H lasiocarpum*, giving, on hydrolysis and hydrogenolysis, products the properties of which are in complete agreement with those described by Men'shikov and Schdanovitch[3] Likewise, *iso*heliotrine gives, on hydrolysis and hydrogenolysis, products having the same properties, including optical rotation, as those reported from heliotrine, despite the differences in rotation of the parent bases

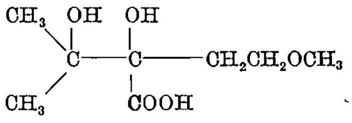
Structure I for heliotric acid, $C_8H_{16}O_4$, the acid resulting from hydrolysis or hydrogenolysis of heliotrine, was established by Men'shikov[3] by oxidation to 2-methyl-4-methoxypentan-3-one, and the same result has been obtained with heliotric acid from *iso*heliotrine Lasiocarpic acid, $C_8H_{16}O_5$, not stable to alkali, was obtained by Men'shikov and Schdanovitch by hydrogenolysis of lasiocarpine and was shown by them to contain one methoxyl and two hydroxyl groups These two hydroxyl groups are now shown to be present as an α-glycol grouping, since on titration with sodium periodate 1 01 moles of periodate are consumed per mole of lasiocarpic acid Moreover, fission of the glycol with periodate



I



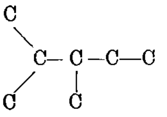
II



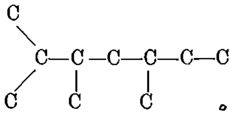
III

leads to the formation of acetone, isolated and identified as its 2,4-dinitrophenylhydrazone Lasiocarpic acid is an α-hydroxy acid, for it gives a yellow colour with ferric chloride and liberates carbon monoxide on warming with concentrated sulphuric acid Only two possible structures for lasiocarpic acid, (II) and (III), are consistent with these facts, and a decision between them can be made on the basis of Kuhn–Roth C-methyl determinations As would be expected, heliotric acid, with one terminal methyl group and a *gem*-dimethyl group, gave 1 6 moles acetic acid Lasiocarpic acid gave 1 6 moles acetic acid, showing that it also contains one terminal methyl group and a *gem*-dimethyl group and therefore possesses structure II

It is noteworthy that, with the exception of angelic acid, a second acid fragment from lasiocarpine, the esterifying acids of pyrrolizidine alkaloids from four genera of the family Boraginaceæ—*Heliotropium*, *Lindelofia*[5], *Cynoglossum*[5] and *Trachelanthus*[5]—all have the same C_7 skeleton (IV), in contrast to the C_{10} di-isoprene necic acids (V) from *Senecio* spp [1] It is probable that the carbon skeleton of the esterifying acid (other than lactic acid) is the same in the case of trichodesmine from *Trichodesma incanum*[3], the only other member of the Boraginaceæ reported to contain pyrrolizidine alkaloids



IV



V

Full details of this work will be published elsewhere

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Preparation of D-Glucose Dibenzamide from Pentabenzoyl-D-α-Glucose

THE usual reaction product of the treatment of the acylated nitriles of aldonic acids with ammonia are the aldose diacetamides[1] A variation of this reaction was found when Hockett and Chandler[2], by treating hexa-acetyl-D-α-glucoheptonic acid nitrile with ammonia, obtained N-acetyl-D-glucofuranosylamine The same product resulted from the action of ammonia on penta-acetyl-aldehydo-D-glucose Later, Niemann and Hays[3] prepared N-acetyl-D-glucofuranosylamine by the action of methanolic ammonia on penta-acetyl-D-β-glucose, a reaction that produced the transformation of the original pyranose ring of the acetylated glucose into a furanose structure

We have found that if pentabenzoyl-D-α-glucose is treated with methanolic ammonia, D-glucose dibenzamide is produced in 28 per cent yield The product is identical with the D-glucose dibenzamide prepared by Brigl, Muhlschlegel and Schinle[4] by the action of the same reagent on pentabenzoyl-aldehydo-D-glucose Melting point and rotatory power were identical for the compounds prepared by the two reactions, and a mixed melting point gave no depression The same penta-acetyl derivative was obtained by acetylation of D-glucose dibenzamide prepared from pentabenzoyl-D-glucose and from pentabenzoyl-aldehydo-D-glucose (melting point, 193–194°, $[\alpha]_D^{22^\circ}$ – 39 7° in chloroform Calculated for $C_{30}H_{34}N_2O_{12}$ C, 58 60, H, 5 54, N, 4 56, found C, 58 86, H, 5 12, N, 4 85 per cent)

The reaction is significant as a demonstration of the influence of the acyl groups in it It is being studied in detail in relation with the theory proposed by Isbell and Frush[5] to explain the formation of aldose-diamide compounds, for which there is experimental proof in the work of Hockett, Deulofeu and Deferrari[6] employing ammonia labelled with nitrogen-15 for the degradation of acylated nitriles of aldonic acids

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Structure of Ribose Anhydride

DURING the removal of the triphenylmethyl (trityl) group from 1 2 3-triacetyl 5-trityl D-ribofuranose, Bredereck, Kothnig and Berger[1] observed the formation of a compound to which they assigned the structure 1 5-anhydro-D-ribofuranose Doubts as to the validity of this structure were raised by two of us, and using the method described by the German workers, a compound was obtained which was shown to have the structure 1 5′ - 5 1′-di-D-ribofuranose anhydride[2] However, owing to the lack of agreement in the specific rotation of the anhydride with that recorded by Bredereck *et al* , it could not be concluded that the two compounds were identical, although apparently the same method of preparation was used in each case

Prior to the publication of the above dimeric structure, preliminary investigations by one of us (R W J) had also led to the conclusion that Bredereck's monomeric structure was untenable[3], though no evidence had then been obtained to indicate an alternative structure Furthermore, the discovery (R W J) of an arithmetical error in the calculation by Bredereck *et al* of the specific rotation

Anhydroribose	Bredereck *et al*	R W J	G R B and M V L
m p	229–230° (sint 225°)	231–232° (sint 223°)	229° (sint 224°)
Specific rotation in water	$[\alpha]_D^{20°}$ +7 8° + 7 9°*	$[\alpha]_D^{20°}$ +8 6° ± 0 5° (*c*, 1 33)	$[\alpha]_D^{15°}$ +9 4° ± 0 5° (*c*, 1 4)
Consumption of periodate		2 00, 1 92, 2 08 mol (no formic acid produced)	2 03, 2 01 mol (no formic acid produced)
Specific rotation of solution after oxidation		$[\alpha]_D^{20°}$ +46 5° ± 0 5°	$[\alpha]_D^{13°}$ +48° ± 0 7°†
Tetra-acetyl anhydroribose			
m p	169°	169–169 5°	168 5–169 5°
Specific rotation in chloroform		$[\alpha]_D^{20°}$ +51 0° ± 0 5° (*c*, 0 97)	$[\alpha]_D^{18\ 5°}$ + 50 6° (*c*, 1 19)

* Arithmetical error corrected

† This was incorrectly published as – 48° We are indebted to Dr Jeanloz for pointing out the mistake and have verified the sign by a second determination (G R B, M V L)

of the anhydride removed the doubt previously expressed[2] as to the identity of the two materials

In the accompanying table, we record the close agreement reached by the various authors, including some fresh data, and we wish to emphasize that the compound originally prepared by Bredereck, Kothnig and Berger is now to be regarded as 1 5′-5 1′-di-D-ribofuranose anhydride

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M V Lock

Department of Chemistry,
University, Manchester 13 Sept 14

[1] *Ber*, 73, 956 (1940)

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[3] Private communication

Quick Test for the Early Diagnosis of Influenza

During infection of mice with influenza virus, the hæmagglutinin inhibitor, normally present in their respiratory mucus, disappears[1]—presumably due to degradation by the enzyme of the multiplying virus[2] Human nasal secretions contain a similar substance which, when acted upon *in vitro* by influenza virus enzyme, loses its inhibitory capacity As the disappearance of inhibitor was shown to be one of the most sensitive diagnostic signs of influenza in mice[3], it seemed promising to apply the same method to the human disease The recent epidemic of influenza *A* in Melbourne offered an opportunity of testing this proposition

Nasal swabs were soaked in 1 0 ml 0 9 per cent sodium chloride solution, and the inhibitory titre of the extracts was determined Since even in normal persons the inhibitor content of nasal secretions varies widely, advantage was taken of the recent work on the adsorptive affinity of mucoids for different strains of influenza virus As established by Stone[4], each inhibitor shows a characteristic pattern when tested against a series of indicator viruses[5], contact with active virus results in differential reduction of titres for the various indicators, that is, in a distortion of the normal pattern

The samples were therefore titrated against three virus strains, *WS*, *MEL*, *LEE*, in parallel In tests on 137 specimens from twenty-nine normal individuals, the average ratio of titres against *WS* *MEL* *LEE* was 10 24 9 For convenience the findings are expressed in terms of the 'inhibitor index', $10 \times \frac{MEL + LEE}{WS}$ Thus the inhibitor index for normal human nasal secretions is 33 with a standard deviation of ± 8 Since the *WS*-inhibitor is the one most readily destroyed, the inhibitor index will rise whenever the mucus is acted upon by a viral enzyme

The accompanying table summarizes the results obtained during the first month of the epidemic The tests applied were (*a*) determination of the inhibitor index, (*b*) amniotic isolation of the virus, (*c*) titration of antibodies directed against the virus particle, and (*d*) estimation of complement-fixing antibody

Contingency Table of Diagnostic Tests for Influenza

Based on the investigation of 84 patients during the 1950 epidemic of influenza *A* in Melbourne

a	*b*		*c*		*d*	
	Virus isolation		Anti-hæmagglutinin		Complement-fixing antibody	
Inhibitor index	+	–	+	–	+	–
> 100 (+ +)	4	0	2	0	3	0
75–100 (+)	6	2	7	0	6	0
50–75 (±)	11	4	6	3	6	4
< 50 (–)	2	28	3	39	2	45

$\chi^2_{ab} = 27\ 9$, $\chi^2_{ac} = 31\ 4$, $\chi^2_{ad} = 40\ 0$

(For purposes of the χ^2-test all inhibitor indices exceeding 50 are considered positive Yates's correction for small numbers was applied)

The χ^2-values calculated relative to the inhibitor index (cf table) are of the same order as those obtained when the three tests are evaluated accordingly ($\chi^2_{bc} = 17\ 1$, $\chi^2_{bd} = 19\ 1$, $\chi^2_{cd} = 41\ 7$), thus proving a very high positive correlation Hence, the proposed procedure may be listed among those giving objective evidence of influenza virus infection in man The technique is simple, and an answer is available within an hour's time

The inhibitor profile remains distorted during the first three to five days after the onset of symptoms, by the time antibody appears, all patients have their inhibitor indices within the normal range (< 50) No deviations from the normal were seen in a limited number of experiments on various other diseases of the respiratory tract (two lobar and three broncho-pneumonias, one atypical pneumonia, two cases each of bronchiectasis, tracheo-laryngitis, and pharyngitis, and seven cases of common cold) Though it is quite realized that the number of controls has to be extended, the information available would suggest that enzymic destruction of the hæmagglutinin inhibitor of nasal mucus is restricted to infection with influenza viruses

A full report on the work will appear elsewhere

I am greatly indebted to my colleagues in the Epidemiological Unit for collecting specimens and for making available the results of their investigations.

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Melbourne Sept 5

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 8

Association for the Study of Animal Behaviour (at the Zoological Society of London, Regent's Park, London, N W 8), at 11 a m—Symposium on "Grazing Behaviour" (to be opened by Sir George Stapledon, F R S, Prof Martin Jones and Dr John Hammond, F R S)

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 6 p m—Dr John C Swallow "The Plastics Industry" (Cantor Lectures) (Further Lectures on January 15 and 22)

Tuesday, January 9

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m—Mr C J Stairmand "The Sampling of Dust Laden Cases"

University of London (at the London School of Hygiene and Tropical Medicine Keppel Street, London, W C 1) at 5 30 p m—Sir Henry Dale, O M, F R S "The Scientific Basis of Medicine 1, The Significance of Acetylcholine as a Chemical Transmitter of the Effects of Nerve Impulses" * (Further Lectures on January 11, 16, 18, 23, 25, 30, February 1, 6, 8, 13, 15, 20, 22, 27, March 1, 6, 8, 13, 15 and 20)

Illuminating Engineering Society (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 6 p m—Mr W Robinson "Brightness Engineering"

Institution of Works Managers, Preston Group (at the Preston and District Building Trades Employers Association Starkie House, Starkie Street, Preston), at 7 p m—Mr W Place "Methods—Time Measurement, a Recent Development in Time Study"

Royal Institute of Chemistry (joint meeting with the Gravesend and District Engineering Society, at the Royal Clarendon Hotel, Gravesend) at 7 30 p m—Mr J Smith "Atomic Reactors, their Development and Economics"

Wednesday, January 10

Society of Chemical Industry, Microbiological Panel of the Food Group (joint meeting with the Society for Applied Bacteriology, at the Medical Society of London 11 Chandos Street, Cavendish Square, London, W 1), at 2 15 p m—Symposium on "The Cytology of Bacteria"

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m—Dr C Potter "Insecticides and their Study" (Fernhurst Lecture)

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m—Scientific Papers

Institute of Petroleum (at Manson House, 26 Portland Place, London, W 1), at 5 30 p m—Papers on "The I P Safety Codes" (Mr E J Sturgess General Considerations, Mr H de Wilde Their Application to Production, Dr F Mayo Their Application to Refining, Mr R L Sarjeant Their Application to Marketing)

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 30 p m—Prof M S Bartlett "The Theory of Statistics"

Royal Microscopical Society, Biological Section (at Tavistock House South, Tavistock Square, London, W C 1), at 6 p m—Dr Joan Lorch "Micro-Dissection Studies on Amœbæ"

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m—A Symposium on 'Hearing Aids"

Wednesday, January 10—Monday, January 15

World Power Conference (at New Delhi, India)—Sectional Meeting, First Plenary Session of the International Commission on Irrigation and Canals, Fourth Congress on Large Dams

Thursday, January 11

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W C 1), at 5 p m—Dr I G H Ishak (Cairo) "Colour Vision Characteristics of Egyptian Trichromats"

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Mr F S Edwards Mr F R Perry and Mr A S Husbands 'Development and Design of High Voltage Impulse Generators"

British Trust for Ornithology in co-operation with the British Ornithologists' Union (at the Zoological Society of London, Zoological Gardens, London, N W 8), at 6 p m—Mr R A H Coombes and others "International Wildfowl Research"

British Institution of Radio Engineers, Scottish Section (at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow), at 7 p m—Mr E D Hart and Mr A G Wray "Frequency Modulation and F M Measuring Equipment"

Liverpool Metallurgical Society (in the Lecture Theatre, Electricity Service Centre, Whitechapel, Liverpool), at 7 p m—Mr H Morrough "The New Nodular Cast Irons"

Friday, January 12

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m—Scientific Papers

Chemical Society, St Andrews and Dundee Section (joint meeting with the St Andrews University Chemical Society, in the Chemistry Department, United College, St Andrews), at 5 p m—Dr R A Raphael 'The Synthesis of some Natural Products by means of Acetylenic Compounds"

University of London (at King's College Strand, London W C 2), at 5 30 p m—Dr Denis Taylor and Mr E H Cooke-Yarborough "The Use of Electronic Measuring Instruments in Nuclear Physics and Nuclear Engineering" * (Further Lectures on January 19, 26, February 2, 9 and 16)

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6 15 p m—Mr I Lubbock "Combustion Problems of Gas Turbines"

Manchester Statistical Society, Industrial Group (at the Albert Hall, Peter Street, Manchester), at 6 45 p m—Mr S Wiseman "Intelligence Testing, its Methods and Statistical Basis"

Saturday, January 13

Institution of Chemical Engineers, Midland Branch (in the Latin Theatre, The University, Edmund Street, Birmingham), at 3 p m—Mr F H Garner and Mr S R M Ellis "Applicability of Vapour-Liquid Equilibria to Extractive Distillation"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Engineering Assistant in the X-ray Section of the Ministry of Supply Engineering Division, for duty in Edinburgh or Glasgow—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 342/50A (January 12)

Physicists and Light Electrical Engineers (Principal Scientific Officer grade) (with a good honours degree and a wide background of research and development experience, particularly in the design and use of magnetic and electronic amplifiers) at the Royal Aircraft Establishment, Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 345/50A (January 12)

Lecturer, with special responsibility in Physics—The Registrar, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (January 13)

Lecturer in Mathematics for B Sc (general) and/or H N C in engineering (mechanical and electrical), at the Luton and Bedfordshire College of Further Education—The Borough Education Officer Education Office, Town Hall, Luton, Beds (January 13)

Mechanical Engineer for the Ministry of Works Engineering Division in London, for service in the Heavy Research Plant Section on the design and execution of large engineering installations for Government Research and Scientific Establishments—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London W C 2, quoting C 652/50A (January 13)

Scientist, Grade III (with a good honours degree, or equivalent, in mathematics, physics or engineering), to carry out operational research—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, endorsed TT/279 (January 13)

Chemists (with honours degree or equivalent) for research and routine investigations on tropical soils and crops in Nyasaland (Ref 27106/17), Kenya (Ref 27106/34), Gold Coast (Ref 27059/268), Malaya (Ref 27106/30), and for soil analysis in Nigeria (Ref 27059/199)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting the appropriate Ref No (January 14)

Economist (Senior Professional Officer, grade III) in the Department of Trade and Industrial Development, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W C 2 (January 15)

Scientific Officers (9) in the Department of Agriculture, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (January 15)

Senior Lecturer in Veterinary Anatomy, a Lecturer in Veterinary Anatomy, a Lecturer in Biology, and an Assistant Lecturer in Biology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N W 1 (January 15)

Dairy Cattle Husbandry Officer—The Director, Animal Breeding and Genetics Research Organization, Glenbourne, South Oswald Road Edinburgh 9 (January 20)

Senior Lecturer in Mathematics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (January 20)

Lecturer in the Department of Zoology, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Rondebosch, January 31)

Senior Assistant in the Department of Anatomy of the Medical School University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Rondebosch, January 31)

Advisory Officer for Agricultural Education—The Director of Education, Castle Street, Worcester

Agricultural Advisory Officer in North-East India—The Secretary Indian Tea Association 39 Lombard Street, London, E C 3

Chemists and Chemical Engineers (Scientific Officer grade) (with a good honours degree or equivalent in chemistry or chemical engineering) in Ministry of Supply experimental establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 726/50A

Lecturer in Chemistry in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St John Street, London, E C 1

Mechanical Engineers in the Colonial Engineering Service as Inspectors of Machinery in the Mines Department of the Federation of Malaya—The Director of Recruitment Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27099/23

Research Officer with degree in physics or equivalent (considerable skill in the finer techniques of physical measurement desirable) a Research Officer, with degree in physics or equivalent, for work on full- or semi-scale plant, eventually to supervise technical investigations on dust and pulverizing, and Research Officers preferably with degree in physics or equivalent, for work on small-scale combustion problems—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey

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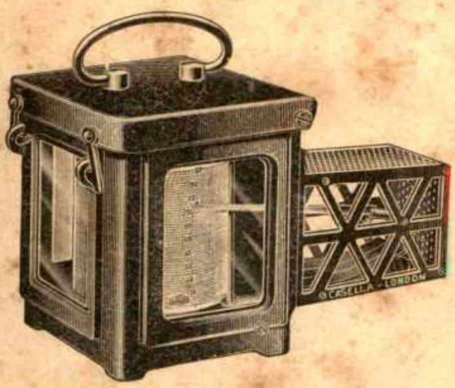

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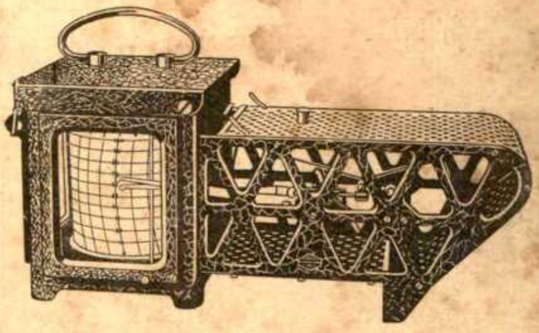

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ADMINISTRATION OF COLONIAL RESEARCH

A WELCOME feature of the reports collected under the title "Colonial Research 1949–50" (see p. 55 of this issue) is the indication that generally, with the notable exception of economic research, shortage of scientific personnel is ceasing to be the handicap to progress that it has hitherto been. In social science there was a marked improvement at the junior levels, and the scheme initiated last year of postgraduate studentships, tenable at universities in the United Kingdom, for training in the social sciences, prior to a research appointment of not less than two years in the Colonies, has been expanded by the addition of four more studentships. The scheme for the employment of American social scientists on research projects in the Colonies, after some preliminary training in the United Kingdom, has also proceeded, and the new Colonial universities are now beginning to sponsor research in the social sciences.

In certain spheres recruitment improved considerably; more than forty geologists, for example, were appointed during the year, the total strength of the scientific staff in the Colonial Geological Surveys increasing from 73 to 110. Increases in staff are also stressed in the report of the Colonial Medical Research Council, while a number of major appointments, such as the directors of the East African Social Science Research Council, the West African Social and Economic Research Institute, the West African Fisheries Research Institute and the East African Virus Research Institute, were also made during the year. Moreover, while, as already indicated, the Colonial universities are making an increasing contribution to Colonial research and, as in previous years, the Colonial Products Research Council's report again bears witness to the important contribution being made by the universities of the United Kingdom in this field, the Colonial Research Council directs attention to the increasing co-operation between Colonial governments and the Department of Scientific and Industrial Research.

Colonial research has lost the direct services of Sir Ian Heilbron, who resigned from the chairmanship of the Colonial Insecticides, Fungicides and Herbicides Committee, which he had held since its inception in 1947, to become chairman of the Advisory Council on Scientific and Industrial Research. In that position, however, his experience of Colonial research, including service on both the Colonial Research Council and the Colonial Products Research Council, should be of increasing value. It is disturbing, however, to find that his successor as chairman of the Colonial Insecticides, Fungicides and Herbicides Committee, Prof. P. A. Buxton, only held that office from August 1949 to April 1950, particularly as the reviews of work given in this report indicate that the scientific work done under that Committee and under the Colonial Products Research Committee is of outstanding interest. That, despite frequent changes of personnel on the respective Councils, there has been a fair measure of continuity in their chairmen and executive officers rather attracts attention to such a rapid change

Lord Hankey, for example, has been chairman of the Colonial Products Research Council since its formation, and Sir John Simonsen its director of research. The Colonial Social Science Research Council has likewise had but one chairman—Sir Alexander Carr-Saunders—and, despite a number of recent changes in its membership, the Colonial Economic Research Committee still has its original chairman, Sir Arnold Plant. Sir John Fryer was chairman of the Committee for Colonial Agriculture, Animal Health and Forestry Research from its formation until his death in November 1948, and the original chairman of the Colonial Medical Research Committee, Sir Edward Mellanby, only resigned in August on retiring from his appointment as secretary of the Medical Research Council.

All this has in itself given some measure of continuity of membership to the Colonial Research Council, of which the Minister of State for the Colonies is chairman and the Deputy Under-Secretary of State in Charge of Economic Affairs vice-chairman, and on which the Advisory Council on Scientific Policy and the Department of Scientific and Industrial Research are both represented. It is important, however, to bear in mind that, apart from its responsibility for co-ordinating the work of the various committees which at present advise the Secretary of State for the Colonies on special aspects of research, the Colonial Research Council, like the Colonial Social Science Research Council and the Colonial Products Research Council and the several committees reporting in "Colonial Research 1949–50", has purely advisory powers. None of these bodies has any administrative or executive responsibility for seeing that recommendations are, in fact, given effect and implemented.

What is lacking in "Colonial Research" is any indication that such responsibility is entrusted in the Colonial Office to men who are capable of assessing the significance of such scientific and technical recommendations and all they involve. It will be noted that, on the contrary, with the exception of those on the Colonial Medical Research Committee, none of the representatives of the Colonial Office on these Councils and Committees has scientific qualifications. It cannot, of course, be assumed that these representatives are the men in the Colonial Office to whom the administration of research is entrusted; but it is reasonable to suggest that the Colonial Office should be actively seeking for experienced scientific men of standing with administrative ability, to whom that executive responsibility could be entrusted, rather than to those who have risen in the administrative class of the Civil Service with no training or understanding of science.

There are two further reasons for directing attention to this aspect of Colonial research at the present time. It will be recalled that, in reviewing expenditure on research and development in its third report for the session 1946–47, the Select Committee on Estimates commented rather strongly on the manner in which administrative control over expenditure on scientific research was being exercised, and the danger of waste if reasonable adaptability was not allowed. The Committee recommended that the existing arrangements for Colonial research expenditure should be included in a review designed to free the responsible officer, so far as is practicable, from over-detailed or harassing external control. While there is no evidence that such a review has been made and changes in practice instituted, the introduction of the Colonial Research Service gives further point to the recommendation. It will not long be possible to attract or retain the services of the ablest young scientific workers if financial control is too restrictive or if the Colonial Research Service is not administered by men in sympathy with the scientific approach and capable of understanding the outlook of the scientific worker, and on the lines so well laid down by the Barlow Committee on Scientific Staff in its report in 1945.

The second reason is also indicated by the Select Committee on Estimates in the report already quoted. Attention is directed to the fact that, despite the various personal links existing between the several Colonial research committees and Government research organizations in Great Britain, the Advisory Council on Scientific Policy had no formal contacts with the Colonial Office organization, and no *locus* to consider the contributions which Colonial research projects may make to the general scheme of Empire research. It therefore recommended that some formal contact should be established between the Advisory Council and the Colonial Research Committee.

In the past four years, the whole situation has grown even more complex, and it can scarcely be pretended that this recommendation is met by having representatives of the Advisory Council on Scientific Policy on the Colonial Research Council. The new Colonial universities are unlikely to make their full contribution to Colonial research for at least a decade. In the meantime not merely the British universities but also the Department of Scientific and Industrial Research are making a contribution which already forms no insignificant proportion of Great Britain's scientific effort. Now, while the wealth of targets in the field of Colonial research is such that useful projects can scarcely fail to be selected in these critical times, it is essential, as was observed by the Advisory Council in the last annual report of the Department of Scientific and Industrial Research, that the tasks for which available resources are used should be, not merely useful, but also the most useful, that can be undertaken for restoring the prosperity of the country, and that every practicable step be taken, once a piece of work is finished, to apply the results in practice.

The present position with regard to Colonial research is that its ramifications and its relationships with the British and Colonial universities, as well as with Government departments in Great Britain and with the Colonial governments themselves, have become so intricate that it could be plausibly argued that Colonial research should be administered independently of the Colonial Office, just as the Lord President of the Council is responsible for the work of the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council, independently of, say, the Home Office. Hence the Colonial Office should, as was implied in the criticism of the Select Committee on Estimates, make it manifest that its administration is thoroughly competent to ensure the wise selection of targets and effective follow-up of results, and to command the confidence alike of its scientific staff and of those men of science who serve on its advisory bodies

It may be recalled that the organization of the Colonial Office was reviewed in a debate in the House of Lords on October 24, when Lord Winster suggested the appointment of a Secretary of State for the Colonial African Empire This suggestion met with little support, but, strangely enough, there was no reference in the debate to the one outstanding lesson offered by the vicissitudes of the East African groundnuts scheme and which, from the recent report of the Overseas Food Corporation, now appears to have been learnt, namely, the imperative necessity for a firm scientific basis for all such schemes, and for ample time for experimental investigation on the spot before large-scale commitments are incurred It is to be hoped that the Select Committee on Estimates and the Advisory Council on Scientific Policy will not fail to look further into the points raised in the 1946–47 report Before the next annual report on Colonial research appears, steps should be taken to establish beyond question the adequacy of the organization of the Colonial Office to deal with its scientific responsibilities, or, if the need be established, to strengthen it to discharge those responsibilities in a way which will command the full confidence of all those scientific workers in any way associated with the work

PHYSICO-CHEMICAL CONSTANTS OF ORGANIC COMPOUNDS

Physico-Chemical Constants of Pure Organic Compounds

By Prof J Timmermans (International Union of Pure and Applied Chemistry) Pp viii+693 (New York and Amsterdam Elsevier Publishing Co , Inc , London Cleaver-Hume Press, Ltd , 1950) 95*s*

PROF. J. TIMMERMANS has done a service to science in bringing together in one volume authoritative values for the main physical properties of a large number of substances in the realm of organic chemistry Up to the present, it has often been a matter of doubt as to the most reliable value to choose from the many to be found in the literature and as to the accuracy of the value when chosen These doubts need no longer exist, now that this volume is available

The author is director of the International Bureau of Physico-Chemical Standards in Brussels and a member of the Committee of Physico-Chemical Data of the International Union of Pure and Applied Chemistry As is stated in the preface, "The volume is among the fruits of a quarter of a century's activity of the International Bureau and combines the results obtained in their laboratories with those provided by a systematic harvesting of the whole of the chemical literature up to January 1st, 1950" But it is more than that, for it is the life-work, almost, of an expert in fine measurement whose steady enthusiasm has inspired the work Prof Timmermans is also the author of a book, "La Notion d'Espèce en Chimie" (Paris Gauthier-Villars, 1928), in which he sets out the precautions necessary before a measured constant may be deemed reliable , the standard of purity of the substance on which the determination is made is of first importance, and certain criteria of purity have to be satisfied That work was brought up to date and translated by R E Oesper and published under the title "Chemical Species" (New York and London Macmillan, 1940)

The present volume is not only useful because it provides in an accessible way reliable values of the physical properties of organic substances, but also because it directs attention to those details to which heed must be given if a measurement is to be of permanent value Those who make use of the book for reference should be careful to read the sixteen pages of the introduction, which set out the rules employed to assess the accuracy and precision of the published values of constants and the influence of the system of units adopted. It is only in the light of the author's remarks in the introduction that the choice of the values in the tables will be understood and their reliability gauged It is to be hoped that one result of the publication of this volume will be that the measurements recorded in the literature will in future be of a higher standard of reliability, and that so many will not fall outside the rules for incorporation in a future extended edition as have had to be discarded in compiling the present volume

The object of the work is set out clearly in the introduction it "records, as completely as possible, those physico-chemical constants of organic compounds which have been measured with sufficient care to warrant their acceptance as data established with a precision worthy of contemporary science". The author states that "in order to facilitate the use of this work we have been careful to reduce the results of different authors to the same system of units, where this has appeared to be useful" It is not always clear where this has been done, and whether the results of some of the older measurements quoted would not need correction to the international scale of temperature

As to the scope of the work, owing to the lack of reliable data it is not possible to provide systematic tables of the chief physical properties of the compounds—such as density, boiling and freezing points, vapour pressures, viscosities, surface tensions, refractive indices, and thermal constants and their variation with temperature—but only those properties of each substance which meet the standards of reliability, and sometimes these are limited to only a few properties Nevertheless, in the 607 pages of tables there is a wealth of highly useful data relating to hundreds of organic compounds A full list of references is given at the end of the volume This follows a short sketch of the history of the systematic investigation of the physical properties of organic compounds which began with the famous work of Kopp on molecular volumes There is a formula index as well as a subject index, giving the names of the compounds and the number of the page on which the name appears Reference, therefore, is easy

This book will be of value to the research chemist, and libraries should possess it for reference

A C EGERTON

A PLANT ALKALOID HANDBOOK

The Alkaloids

Chemistry and Physiology. Edited by R. H. F. Manske and H. L. Holmes. Vol. 1. Pp. viii+525. (New York: Academic Press, Inc., 1950.) 10 dollars.

ALKALOIDAL chemistry has expanded over the past few decades to such an extent that it can be no longer exhaustively or even adequately treated by single authors, as was formerly possible in such classical works in this field as those of Bruhl and Henry. Even so, the present work, in which the editors "aim to assemble in five volumes all the pertinent knowledge of the chemistry and pharmacology of the alkaloids", is a bold venture; there is a danger of lack of uniformity of treatment inevitable with a diversity of authors, however distinguished their own contributions to original knowledge in this field.

In this book the seven chapters are devoted to sources of alkaloids and their isolation (R. H. F. Manske), alkaloids in the plant (W. O. James), pyrrolidine alkaloids (L. Marion), senecio alkaloids (N. J. Leonard), pyridine alkaloids (L. Marion), chemistry of the tropane alkaloids (H. L. Holmes), and strychnos alkaloids (H. L. Holmes). This first volume is naturally a shop window, but if the succeeding volumes keep up the standard attained in this one the editors and authors will earn the plaudits of all organic chemists who acquire or who can consult such a noteworthy production.

The formulæ are printed in a clear form acceptable to chemists, and the tabular presentation of physical and other data is a pleasing feature of the work. In dealing with the structure of strychnine and other alkaloids, the accepted formulæ, with numbering, could with advantage have been placed very early in the appropriate chapter.

Chapters 1 and 2 are highly stimulating essays containing, as they do, material not usually found in the routine alkaloidal text-book. Workers on alkaloids must often have felt that the botanical classification of species must bear some relation to the alkaloidal types found in the different species; a discussion of this problem is found in Chapter 1. The reader's attention is directed to Hutchinson's "The Families of Flowering Plants", in which the evolution of flowering plants is portrayed, and to the orders which are alkaloid-bearing. The time is evidently still not ripe for any convincing treatment of this subject; the observations that nicotine occurs in flowering plants (Spermatophyta) and in the vascular cryptogams (Pteridophyta) show that considerable caution must be exercised in drawing generalizations.

The contents of Vols. 2, 3 and 4 are listed on the paper cover of Vol. 1, but there is no mention of the contents of Vol. 5. Adequate treatment of the pharmacology of the alkaloids is foreshadowed in the editorial preface, as might be expected from the title of the series. From this first volume, however, it is not clear how this aim is going to be attained. Presumably Vol. 5 will be devoted in part at least to the pharmacology, since there is only cursory and quite inadequate mention of any pharmacology in the present volume. It is eminently desirable that the pharmacology should be written by a pharmacologist, but to deal with all the pertinent knowledge of this aspect of the alkaloids will not be a light undertaking.

This volume is singularly free from errors. One curious slip occurs on p. 279, where nortropane is said to be isomeric with ethylpiperidine. The formula of strychnine, in vogue until quite recently, is portrayed on p. 418 with a missing methylene group. For the decomposition of gold and platinum salts, it is true that hydrogen sulphide may be used (p. 274); but Dudley's silver method is infinitely preferable as it leaves no acidity and no colloidal metal sulphide. It is surprising to find in an American publication Adams's catalyst referred to repeatedly and uniformly as Adam's catalyst.

The subject-matter is reasonably up to date, and to keep it so the editors propose to issue supplements at periodic intervals. HAROLD KING

SEVERI'S COLLECTED WORKS

Francesco Severi: Memorie Scelte

Vol. 1. A cura di Beniamino Segre. (Comitato Nazionale per le onoranze a Francesco Severi.) Pp. xx+458. (Bologna: Dott. Cesare Zuffi, 1950.) 4,000 lire.

AS already noted in *Nature* of June 10, p. 925, the national committee formed to organize the celebration of Prof. Severi's scientific jubilee decided to publish a selection of his works in four volumes. The appearance of the first volume provides an occasion for a survey, perforce brief and incomplete, of the author's productions and their relation to the previous literature.

During his fifty years activity, Severi has sometimes built magnificently on existing foundations; at other times he has worked from original concepts of great power and fecundity. While many eminent mathematicians contrive to live on the discoveries they have made in early years, Severi, at the age of seventy, constantly reveals fresh enterprise and continues to inspire a large band of disciples. An examination of his principal researches, which fall roughly into four groups, will make this plain.

The first category, represented by the present volume, comprises the higher projective geometry. Here the main influence is his teacher Corrado Segre, the most skilled exponent of the synthetic technique. But, far from contenting himself with the master's methods and aims, Severi has ranged wide, making great advances in such fields as Schubert's enumerative geometry, Grassmann's representation of linear spaces, and the foundations of algebraic geometry; to the latter subject is devoted a memoir published as recently as 1948.

The second class includes the birational geometry of surfaces and manifolds, dealing with properties which are invariant under birational transformation. In 1903, about ten years after Castelnuovo and Enriques had begun their great task of creating the theory *ab initio*, Severi was to make his first contributions; he proceeded to fill lacunæ, simplify proofs and, eventually, to sketch the difficult (and still incomplete) extension to manifolds in general. To this period belongs the prize memoir, written in collaboration with Enriques, on hyperelliptic surfaces; here again it is noteworthy that these researches are continued nearly forty years later, in the treatise on quasi-Abelian functions (*Nature*, October 16, 1948, p. 593).

In the third category the above problems are treated by the transcendental methods devised by Abel and Riemann for curves, and first applied in detail to surfaces by Picard, during the last years of the nineteenth century To this subject Severi has made fundamental contributions, the first of which run parallel to results of Castelnuovo and Enriques, while the last are of quite recent date The most celebrated work in this field is the memoir (1906) which shows that, on an algebraic surface, any algebraic curve is equivalent to a linear combination of a finite number of such curves , from this stem various important consequences in the so-called theory of the base

The fourth group, closely linked with the second and third, originates in the work of Picard, but reaches its full stature in the researches of Poincaré in the topology of manifolds From Poincaré these ideas passed to Lefschetz, who, in 1917, began the systematic development of topological and transcendental methods in algebraic geometry, deriving in the process inspiration from previous work of Severi Some ten years later, Severi himself took over these tools, which in his hands have since yielded abundant results , among them must be noted his extension (1934) of the theory of the base to any manifold, and his invention (1932) of systems of equivalence In the theory of surfaces, for example, the latter concept enables him to define rational series of points, whereas the preceding theory contemplated only rational systems of curves These ideas, which to-day are far from being fully exploited even in the case of surfaces, have already given rise to a considerable literature, in virtue of the fact that they span, not only classical birational geometry, but transcendental and topological theory as well

To the above list should be added a number of important papers on function theory and an entire series of treatises, most of them based on lectures, dealing with geometry and analysis All this work is informed with the greatest breadth and originality, and in it versatility of method vies with elegance of presentation It is characteristic of Severi that he should have found time and interest to write a brilliant text-book of infinitesimal calculus, the notes and exercises of which provide an introduction to practically the whole of pure mathematics

Yet even here, as in the papers on analysis, one immediately discerns the Italian geometer In precisely what the classical Italian geometry consists it is by no means easy to explain , though, in essence, it is always concerned with the properties of polynomials, its most successful instruments of research are of quite another character than algebraic An excellent example is furnished by the memoir, printed in the present volume, on the intersection of manifolds , this is devoted to an array of problems, each of which seeks the number of solutions common to a system of equations Yet, in any given case, it would not only be difficult to set down these equations it would be futile

A second illustration is Castelnuovo's theorem on the conditions of rationality of a surface—an algebraic question, if ever there were one , nevertheless, in the past fifty-five years, no important variant of the original geometrical proof has been found This situation is typical throughout the subject in most parts of projective and birational geometry the combined resources of modern algebra and topology have not merely failed to solve the outstanding problems, but have hitherto proved powerless to attack the majority of questions to which geometers have already provided solutions. In fact, the algebraists who, during the past twenty years, have sought to revise classical methods, have scarcely begun to take the measure of their difficulties , if they are to succeed, algebraic technique must sooner or later be transformed beyond recognition

It remains to add that the present volume has been produced under the able direction of Prof B Segre, who contributes a short preface , that Severi himself has interwoven valuable commentaries here and there , that the book contains a complete list of the author's publications to the end of 1949 , and that printing and binding are worthy of the contents

L Roth

AMERICAN SPIDERS

American Spiders

By Dr. Willis J Gertsch (New Illustrated Naturalist Series) Pp xiii+285+64 plates (New York D Van Nostrand Co , Inc , London Macmillan and Co , Ltd , 1949) 52*s* 6*d* net

Dr WILLIS J GERTSCH is an official of the American Museum of Natural History who has long been known for his interest in spiders It may be said at once that his book is a model for anyone who has to attempt the difficult task of displaying before the general reader a specialist's study of a remarkable group of animals

First, he introduces the reader to the Arachnida as a whole, and then, in three chapters, tells the story of the spider's life This has the merit of being written consistently from the point of view of a man of science, and it is thoroughly up to date All the traditional mistakes, half-truths and partial revelations are in these pages replaced by the latest views or corrected by the most recent discoveries The chapter on the sex life of spiders may seem to be disproportionately long, but the author might justify this on the ground that courtship is more highly developed among spiders than any other invertebrates, and it provides unrivalled opportunities for the study of instinctive actions, sexual selection and other theoretical topics

After an account of the evolution of spiders, Dr Gertsch devotes four chapters to the different families One of these, on the Mygalomorphæ, the miscalled tarantulas, is particularly welcome to European readers, for the sub-order is not well represented in European fauna nor adequately described in the literature Nor does the author omit the primitive Liphistiidæ or the rare Hypochilidæ, the scientific interest of which is great , in fact, he shows throughout a striking wisdom in the mention of details (such as the two-segmented anterior spinnerets of *Atypus*) which are of true biological significance

Dr Gertsch makes an attempt to find some alternatives to the usual Latin family names, but when this leads him to write of "Feather-footed" or "Ogre-faced" spiders, it may be doubted whether the effort is worth while But this is a detail This book covers a wide field—so wide that it includes the spider in mythology, medicine and economics—and covers it pleasantly, accurately and authoritatively The illustrations in colour and photogravure, which deserve a special word of praise, surpass anything else in the spider books of to-day

The book is expensive , but it is well worth its price There is no other which could be more confidently recommended to the beginner in arachnology, nor, indeed, to others

T H Savory

Viscometry

By Dr A C Merington Pp viii+142 (London Edward Arnold and Co , 1949) 16*s* net

THIS monograph on the measurement of viscosity is intended chiefly for the research worker who needs an up-to-date survey of the many available methods and their advantages and limitations The first four chapters deal with the general principles of viscometry, the conventional absolute methods, and their adaptation for relative measurements The more important technical viscometers are then described, and tables for converting the readings of the Redwood No 1, Saybolt and Engler instruments to kinematic viscosities are given in an appendix A chapter on gases gives an account of the standard capillary-flow experiments, and also those methods particularly applicable to vapours and to work at low temperatures Miscellaneous methods described include Bridgman's experiments with a falling-cylinder system and Rhodin's direct-reading instrument The special problems of measurements on very viscous materials (with viscosities of 10^3–10^{20} poises) are discussed, with a warning note as to the urgent importance of temperature control The final chapter on applications to rheology deals with the chief classes of anomalous viscosity and gives some of the methods of measuring velocity gradient directly

Applications to particular industries are mentioned briefly in the text, with reference to comprehensive bibliographies at the end of each chapter, totalling, in all, several hundred original papers In this respect the book is almost like the index volume to an encyclopædia, and it should be invaluable to the worker seeking concise and rapid direction on some special problem in his own field This is the chief purpose for which the book was written , but it can also be recommended as an excellent critical discussion of a branch of physics which, perhaps because of its development on the technical side, often figures rather briefly in the standard academic books The author is a senior scientific officer at the Ministry of Supply

G R NOAKES

Lessons on Soil

By Sir E J Russell Second edition Pp xx+134 (Cambridge At the University Press, 1950) 7*s* 6*d*

MANY years ago Sir John Russell was permitted to give some lessons to some of the children of the village school at Wye When he removed to Rothamsted he was invited to continue his lessons with the third form at St George's, Harpenden Not surprisingly, his subject was the soil, and, before his lessons began, the pupils were warned that the material taught would be modified according to their reactions and, later, published His book first appeared in 1911 and, since that time, has been reprinted a number of times Now, after an interval of twenty years, Sir John has prepared a second edition which, although bringing the factual material to date, repeats the pattern of the first issue of thirty-nine years ago Nor was there need for change

From the beginning the author invited the teacher who might make use of the book to use it only as an aid to his own and his pupils' observations "No description or illustration can take the place of direct observation , the simplest thing in Nature is infinitely more wonderful than our best word pictures can ever paint it " Each lesson, therefore, is designed so that the teacher of soil science may make use of local illustrations, although with each topic he is given practical details on how to make the lesson arresting and remembered The text is simply written and easy to follow, the diagrams and photographs clear and relevant, and, altogether, Sir John has written a text-book for teachers which should serve as encouragement and guide to any other former presidents of the British Association who care to follow suit Teachers of biology will be grateful to him for all the practical suggestions in his book

T H HAWKINS

New Biology, 9

Edited by M L Johnson and Michael Abercrombie Pp 128+10 plates (Harmondsworth Penguin Books, Ltd , 1950) 1*s* 6*d*

THE ninth issue of "New Biology" contains two articles dealing with insect movements One, by C B Williams, deals with the deliberate movement of butterflies by migration, while the other, by C G Johnson, describes the accidental distribution of insects by drift "on the wings of the wind" Williams discusses the evidence which indicates that migration in more than three hundred species of butterflies and in a large number of moths occurs in practically all parts of the world from the equator to the Arctic Circle Besides giving examples of the aerial dispersal of insects by wind, Johnson discusses factors influencing aerial populations of insects as well as recent research at Rothamsted and Cardington

In another article I Berenblum sums up the main results of inquiries into the causes of cancer and shows that a real understanding of the difference between a cancerous cell and a normal one needs exhaustive investigation of the processes which go on inside cells Prof W Rowan examines Canada's premier problem of animal conservation, namely, the periodic scarcity of the Canadian snowshoe rabbit which is the mainstay of certain predatory fur-bearing mammals and meat-eating birds Other articles include one by Prof C W Wardlaw on the male fern, B A Kilby on phosphorus drugs and insecticides, and R F Ewer on recent researches on whales

Principles of High-Polymer Theory and Practice

Fibers, Plastics, Rubbers, Coatings, Adhesives By Prof Alois X Schmidt and Prof Charles A Marlies (McGraw-Hill Chemical Engineering Series) Pp xii+743 (New York and London McGraw-Hill Book Co , Inc , 1948) 45*s*

THE authors have set themselves the task of describing in a single volume the fundamental chemical and physical principles underlying the technology of high polymers—both natural and synthetic Early chapters deal with definitions and fundamental concepts, molecular forces and an interpretation of the special properties of high polymers There follow chapters describing the formation and structure of high polymers and their solubility and molecular-weight relationship The subject of moulding and manipulation is introduced by a general account of rheological principles The first part of the book is concluded with chapters on mechanical, electrical, thermal and optical properties In the second part the preparation, properties and applications of each type of polymeric material are described in turn

The account is clear and precise throughout, and the book should serve as a useful introduction to the vast field of high polymers

POLARIZATION OF THE SUNLIT SKY

By Prof S CHANDRASEKHAR, F.R.S., and DONNA ELBERT
Yerkes Observatory, University of Chicago

IT is well known that Lord Rayleigh accounted for the principal features of the illumination and the polarization of the sunlit sky in terms of the laws of scattering now associated with his name. On Rayleigh's interpretation, the deep blue colour of the sky at the zenith is related to the λ^{-4} dependence of the scattering coefficient on wave-length and the fact that for small optical thicknesses, τ_1, the intensity of the diffusely transmitted light is proportional to τ_1. Similarly, the strongly varying polarization of the sky radiation, and in particular the maximum polarization in a direction at right angles to the direction of the sun, is related to the fact that on Rayleigh's law the light scattered at right-angles to the direction of incidence should be completely plane-polarized, whereas that scattered in the forward or the backward direction should have the same polarization as the incident light. Since this explanation is based on laws valid only for the elementary acts of single scattering, we cannot expect it to account for those features of the sky radiation which are to be traced directly to the admixture, in the observed light, of light which has suffered more than one scattering process in the atmosphere; and among the most striking of these latter features is the phenomenon of the *neutral points* where the polarization is zero. Thus, it is found that there are in general two neutral points on the principal meridian (that is, the meridian containing the sun). For angles of incidence not exceeding 70° these neutral points occur about 10–20° above and below the sun; these are the neutral points of Babinet and Brewster, respectively. On the other hand, when the sun is low, then near the horizon opposite the sun and about 20° above the anti-solar point a new neutral point occurs; this is the Arago point. These facts should be contrasted with what should be expected on the laws of single scattering, namely that the polarization should be zero in the direction of the sun.

The neutral points were observed and discussed a great deal during the nineteenth century, culminating in the early years of this century in the monumental work of Dorno[1]. Dorno not only observed the neutral points on the principal meridian, but he also investigated in detail the continuation of these neutral points over the entire hemisphere along the so-called 'neutral lines'. These lines separate the regions of positive from the regions of negative polarization and show a remarkable dependence on the direction of the sun (see Fig 2).

During the nineteenth century the existence of these neutral points and their behaviour with the direction of the sun were regarded as one of the most remarkable phenomena in meteorological optics. Considerable thought was accordingly given to accounting for them by many investigators, including Arago[2], Brewster[3], Soret[4], Hurion[5], Pernter[6], Exner[7], Jensen[8] and Ahlgrimm[9], among others. It was, however, Soret who first clearly recognized that the occurrence of the neutral points must be due to the presence of secondary and higher orders of scattering. To substantiate this idea, Soret gave a semi-quantitative theory of the phenomenon by superposing the radiation resulting from the primary scattering by an element of volume on the secondary scattering by the same element of volume, on the assumption that the sources of primary scattering are located principally in the plane of the horizon (cf van de Hulst[10]). Soret's ideas were extended and worked out in great detail by Ahlgrimm. But Ahlgrimm's developments are restricted by his assumption that the entire phenomenon could be accounted for by considering the scattering which takes place in a small spherical volume, and by his neglect of all orders of scattering higher than the second and the gradual attenuation of the incident light of the sun and its replacement by scattered light diffused through the medium. These are clearly very severe limitations, and one can question whether the explanation of the phenomenon given on such premises really goes beyond the simple recognition that we *can* understand the phenomenon *if* we take into account the higher orders of scattering.

It is clear that a rigorous theory allowing for all orders of scattering cannot be developed without deriving the equations governing the transfer of radiation in an atmosphere in which each element scatters in accordance with Rayleigh's laws. But these equations were formulated only so recently as 1946[11]. However, the need for a development along these lines was clearly stated in 1913 by L V King in a paper of great interest[12]. However, King decided against an exact treatment of the problem with the remark, "The complete solution of the problem from this aspect would require us to split up the incident radiation into two components one of which is polarized in the principal plane and the other at right-angles to it; the effect of self-illumination [that is, of the higher orders of scattering in our present terminology] would lead to two simultaneous integral equations in three variables the solution of which would be much too complicated to be useful". With this comment, King restricted himself to the problem

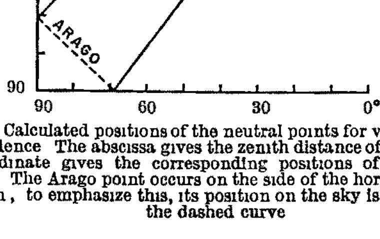

Fig 1 Calculated positions of the neutral points for various angles of incidence. The abscissa gives the zenith distance of the sun, and the ordinate gives the corresponding positions of the neutral points. The Arago point occurs on the side of the horizon opposite the sun; to emphasize this, its position on the sky is indicated by the dashed curve

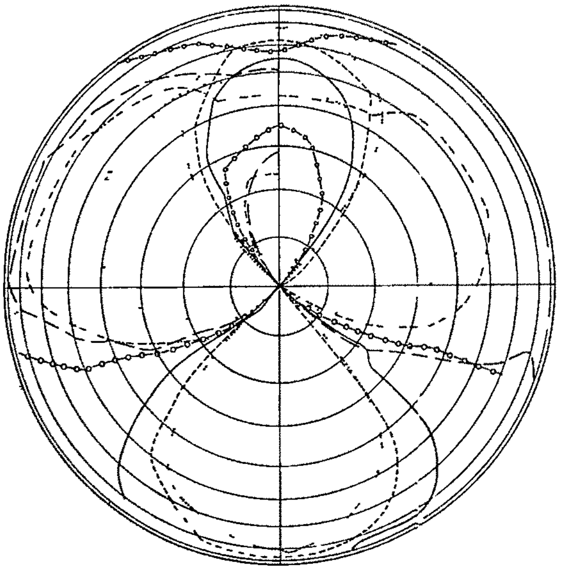

Fig 2 Dorno's observations of the neutral lines on May 17, 1917, at Davos The various curves were determined during the following times when the zenith distance of the sun varied by the amounts given

	7^p 19 – 7^p 28	θ_0 = 87° 10′ – 0°
- - - - - - -	6^p 13 – 6^p 33	θ_0 = 78° 14′ – 81° 30′
———————	5^p 14 – 5^p 34	θ_0 = 68° 20′ – 71° 44′
-o-o-o-o-o-	3^p 15 – 3^p 42	θ_0 = 48° 12′ – 52° 40′
— — —	9^a 9 – 9^a 34	θ_0 = 44° 21′ – 40° 33′
– – – –	9^a 44 – 10^a 11	θ_0 = 39° 5′ – 35° 26′
	12^p 56 – 1^p 14	θ_0 = 29° 30′ – 31° 26′

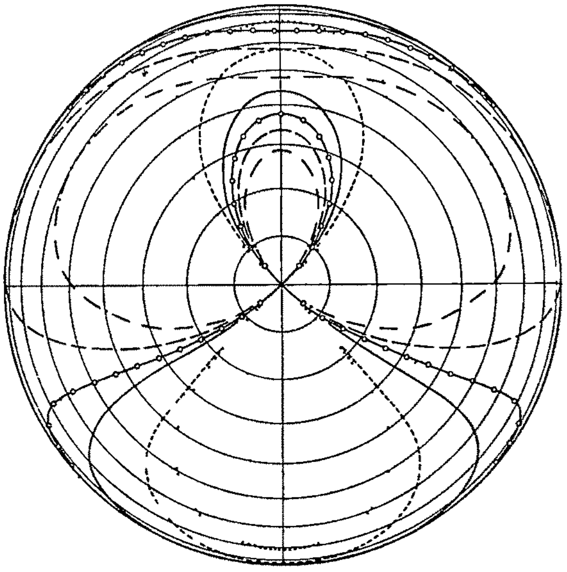

Fig 3 The neutral lines as predicted by the theory The various curves refer to the following zenith distances of the sun

$\theta_0 = 90°$, ——— $\theta_0 = 58\ 7°$, — — $\theta_0 = 43\ 9°$,
- - - - - $\theta_0 = 76\ 1°$, -o-o-o- $\theta_0 = 50\ 2°$, — — $\theta_0 = 36\ 9°$,

The curves in this figure which roughly correspond to Dorno's observations are marked similarly

of the general illumination of the sky and worked out a theory on assumptions which did not allow for the partial polarization of the radiation field or the anisotropy of the scattered radiation In the later developments along the lines initiated by King, by Tichanowsky[13], Chapman and Hammad[14], the angular distribution of the scattered radiation is allowed for in accordance with the 'phase function' $3(1 + \cos^2 \Theta)/16\pi$ but this law gives the angular distribution only for incident natural light and is not of general applicability However, there exists an investigation by Tichanowsky[15] and a later one by Hammad[16] in which the secondary scattering is treated correctly. But none of these latter investigations has led to numerical results relating to the neutral points , and, in any case, orders of scattering higher than the second are always ignored and, moreover, no attempt is made to take into account the effect of the reflexion by the ground

The foregoing brief account of the earlier work on the illumination and the polarization of the sky emphasizes the need for answering the following two questions First, what is the best way in which we can characterize a general partially polarized radiation field in order that the exact equations of the problem can be correctly formulated ? Secondly, is there a basic problem the solution of which will provide a simple and a convincing explanation of the phenomenon of the neutral points and lines ?

These questions have been considered by one of us in recent years (see "Radiative Transfer", by S Chandrasekhar, Oxford, 1950), and a theory has been developed which provides the exact solution of a problem in terms of which it appears that we can account for all the essential features of the phenomenon of the neutral points and lines Actually the solution of the mathematical problem was obtained three years ago[17] The theory is described and briefly illustrated in "Radiative Transfer" (chapter 10, see particularly § 73); but it is only during the past year that we have made sufficiently extensive calculations to provide detailed comparisons between the predictions of the theory and the observations But before we describe these newer results of our calculations, it may be of interest to summarize briefly the manner in which the two questions which we raised earlier were answered

Considering first the most convenient characterization of polarized light, we observe that, to describe a general radiation field which is partially plane-polarized[18], we need three parameters to specify the intensity, the degree of polarization and the plane of polarization But it would scarcely be possible to include such diverse quantities as an intensity, a ratio and an angle in any symmetrical way in formulating the basic equations It appears that for these latter purposes the most convenient representation of polarized light is by a set of parameters first introduced by Stokes[19] in 1852 In spite of the fundamental importance of these parameters they do not seem to be generally known for example, they are not to be found in any of the standard books on optics However, the meaning of these parameters for a partially plane-polarized beam is particularly simple Let l and r refer to two arbitrarily chosen directions at right-angles to one another in the plane transverse to the direction of propagation of the beam The intensity $I(\psi)$ in a direction at an angle ψ to the direction of l must go through two complete cycles as ψ goes through 360°, it must therefore be expressible in the form

$$I(\psi) = I_l \cos^2 \psi + I_r \sin^2 \psi + \tfrac{1}{2} U \sin 2\psi \qquad (1)$$

The coefficients I_l, I_r and U in this Fourier representation are the Stokes parameters In terms of these parameters the direction, χ, of the plane of polarization and the degree of polarization, δ, are given by

$$\tan 2\chi = U/(I_l - I_r) \qquad (2)$$

and

$$\delta = (I_l - I_r) \sec 2\chi/(I_l + I_r) \qquad (3)$$

The additive property of the Stokes parameters which makes them so convenient for treating transfer problems is evident from the representation (1) If two independent streams of polarized light are mixed, then the Stokes parameters characterizing the mixture is the sum of the Stokes parameters of the individual streams

In terms of the Stokes parameters a law of scattering is specified by a matrix, since an elementary act of scattering results in a linear transformation of the parameters Consequently, by considering the intensity as a vector $\boldsymbol{I}$ with the components I_l, I_r and U and replacing the 'phase function' commonly introduced to describe the angular distribution of the scattered radiation by a 'phase matrix', we can formulate the basic equations without much difficulty[20] Once the equation of transfer has been formulated in the manner we have described, the next question concerns the problem which we wish to consider as basic in the theory of the illumination and the polarization of the sky This is provided by the following standard problem in the theory of diffuse reflexion and transmission

A parallel beam of radiation of net flux $\pi\boldsymbol{F} = \pi(F_l, F_r, F_U)$ per unit area normal to itself in the three Stokes parameters is incident on a plane-parallel atmosphere of optical thickness τ_1, in some specified direction $(-\mu_0, \varphi_0)$, where μ denotes the cosine of the angle to the outward normal and φ the azimuthal angle It is required to find the angular distribution of the light diffusely transmitted below the surface $\tau = \tau_1$

The foregoing problem has been solved exactly and the solution is given in "Radiative Transfer" (§ 71) This is not the place to describe the details of the method of solution, suffice it only to say that the solution was made possible by the existence of certain invariances which the laws of diffuse reflexion and transmission by plane-parallel atmospheres must satisfy (These invariances form the basis of the developments summarized in "Radiative Transfer')

We are, of course, particularly interested in the case when the incident light is natural In this case $F_l = F_r = \frac{1}{2}F$ (where πF denotes the net flux of the incident natural light) and $F_U = 0$ In these circumstances the intensity and the polarization of the sky as witnessed by an observer at $\tau = \tau_1$ and in the direction (μ,φ) are governed by the equations given below In these equations I_l and I_r refer to the intensities in directions (in the transverse plane) parallel and perpendicular, respectively, to the meridian passing through the direction specified by (μ,φ) We have

$$\begin{aligned} I_l(\mu,\varphi,\ \mu_0,\varphi_0,\ \tau_1) = {} & \frac{3}{32}\,\frac{F\mu_0}{\mu - \mu_0} \\ & \times [\{\psi(\mu_0) + \chi(\mu_0)\}\ \xi(\mu) + 2\ \{\phi(\mu_0) + \zeta(\mu_0)\}\ \eta(\mu) \\ & - \{\xi(\mu_0) + \sigma(\mu_0)\}\ \psi(\mu) - 2\ \{\theta(\mu_0) + \eta(\mu_0)\}\ \phi(\mu) \\ & + 4\mu\mu_0\ (1-\mu^2)^{1/2}\ (1-\mu_0^2)^{1/2}\ \{X^{(1)}(\mu_0)\ Y^{(1)}(\mu) \\ & - Y^{(1)}(\mu_0)\ X^{(1)}(\mu)\}\cos(\varphi_0 - \varphi) \\ & - \mu^2(1-\mu_0^2)\ \{X^{(2)}(\mu_0)\ Y^{(2)}(\mu) - Y^{(2)}(\mu_0)\ X^{(2)}(\mu)\} \\ & \times \cos 2(\varphi_0 - \varphi)], \end{aligned} \qquad (4)$$

$$\begin{aligned} I_r(\mu,\varphi,\ \mu_0,\varphi_0,\ \tau_1) = {} & \frac{3}{32}\,\frac{F\mu_0}{\mu - \mu_0} \\ & \times [\{\psi(\mu_0) + \chi(\mu_0)\}\ \sigma(\mu) + 2\ \{\phi(\mu_0) + \zeta(\mu_0)\}\ \theta(\mu) \\ & - \{\xi(\mu_0) + \sigma(\mu_0)\}\ \chi(\mu) - 2\ \{\theta(\mu_0) + \eta(\mu_0)\}\ \zeta(\mu) \\ & + (1-\mu_0^2)\ \{X^{(2)}(\mu_0)\ Y^{(2)}(\mu) - Y^{(2)}(\mu_0)\ X^{(2)}(\mu)\} \\ & \times \cos 2(\varphi_0 - \varphi)], \end{aligned} \qquad (5)$$

and

$$\begin{aligned} U(\mu,\varphi,\ \mu_0,\varphi_0,\ \tau_1) = {} & \frac{3}{16}\,\frac{F\mu_0}{\mu - \mu_0} \\ & \times [2\ (1-\mu^2)^{1/2}\ (1-\mu_0^2)^{1/2}\ \mu_0\ \{X^{(1)}(\mu_0)\ Y^{(1)}(\mu) \\ & - Y^{(1)}(\mu_0)\ X^{(1)}(\mu)\}\sin(\varphi_0 - \varphi) \\ & - \mu\ (1-\mu_0^2)\ \{X^{(2)}(\mu_0)\ Y^{(2)}(\mu) - Y^{(2)}(\mu_0)\ X^{(2)}(\mu)\} \\ & \times \sin 2(\varphi_0 - \varphi)], \end{aligned} \qquad (6)$$

where ψ, ϕ, , $Y^{(2)}$ are twelve functions of the single variable μ These functions are defined in "Radiative Transfer", p 269 However, it may be stated here that the eight functions, ψ, ϕ, χ, ζ, ξ, η, θ and σ, can all be expressed in terms of two pairs of functions X_l, Y_l and X_r, Y_r A tabulation of the four pairs of functions for various values of τ_1 provides, therefore, the complete solution of the problem

Before we can apply the foregoing solution to the problem of the illumination of the sky, we must consider the effect of the ground at $\tau = \tau_1$ The solution expressed by the formulæ (4)–(6) assumes that the ground is a perfect absorber However, if the law of reflexion by the ground is specified, then it is not a difficult matter to relate the solution of the problem when there is a ground to the solution of the standard problem This reduction is particularly simple if it is assumed that the ground reflects according to Lambert's law with an albedo λ_0, that is, the light reflected by the ground is unpolarized and uniform in the outward hemisphere independently of the state of polarization and the angular distribution of the incident light, and that, further, the outward flux of the reflected light is always a certain fixed fraction λ_0 of the inward normal flux of the radiation incident on the surface In this latter case, the corrections to I_l, I_r and U given by equations (4)–(6) are .

$$I^*_l = \frac{\lambda_0}{4(1 - \lambda_0\bar{s})}\,\mu_0 F\,\{\gamma_l(\mu_0) + \gamma_r(\mu_0)\}\,[1 - \gamma_l(\mu)], \qquad (7)$$

$$I^*_r = \frac{\lambda_0}{4(1 - \lambda_0\bar{s})}\,\mu_0 F\,\{\gamma_l(\mu_0) + \gamma_r(\mu_0)\}\,[1 - \gamma_r(\mu)], \qquad (8)$$

and

$$U^* = 0, \qquad (9)$$

where γ_l and γ_r are two further functions of μ (related, however, to X_l, Y_l and X_r, Y_r) and $\bar{s}$ is a certain constant depending only on τ_1

While the solution described by the foregoing equations was obtained some three years ago, a detailed comparison of the predictions based on this solution with the results of observations had to await the tabulation of the basic eight functions X_l, Y_l, , $X^{(2)}$ and $Y^{(2)}$ of μ This tabulation has now been completed, and the following is a brief summary of the results we have obtained

The calculations have been made for a number of values of τ_1 But for purposes of illustration we shall restrict ourselves in this article to the case $\tau_1 = 0$ 15 this is approximately the value of the optical thickness at λ 4500 A

First considering the degree of polarization for various angles of incidence, we determined the neutral points which occur on the principal meridian both

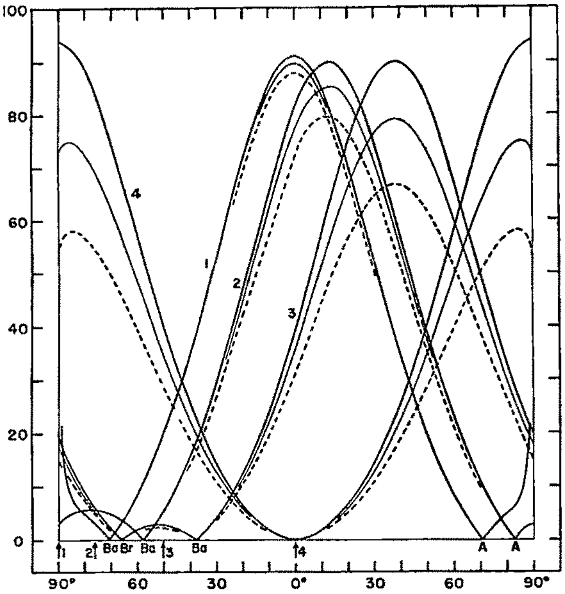

Fig 4 Variation of the degree of polarization in the principal meridian for various angles of incidence The abscissa gives the zenith distance and the ordinate gives the degree of polarization in per cent The curves marked 1, 2, 3 and 4 represent the variation for the angles of incidence θ_0 = 90°, 76 1°, 50 2° and 0°, respectively The thick solid curves are obtained before any ground corrections have been applied The dashed curves are obtained if we allow for a ground reflecting according to Lambert's law with an albedo λ_0 = 0 25 The thin intermediate curves are obtained if λ_0 = 0 10 The positions of the neutral points are also indicated

with and without the ground correction It was found that the ground correction even with an albedo as high as 25 per cent did not make any sensible difference to the positions of the neutral points[21] This independence of the neutral points of the ground correction is not difficult to understand The laws of Rayleigh scattering give the maximum polarization for the scattered light, all other laws give much less polarization A ground reflecting according to Lambert's law can therefore scarcely compete with Rayleigh scattering for producing polarization The effect of reflexion by the ground is therefore essentially one of adding a component of natural light to the polarized light already present Consequently, we can expect the reflexion by the ground to reduce the degree of polarization, but not turn the plane of polarization or change the direction of zero polarization

The results of the calculations on the neutral points are summarized in Fig 1 It will be seen that the calculations predict the occurrence of neutral points in the manner they are observed In particular, it will be noticed that the Brewster point sets when the angle of incidence is about 68°, simultaneously the Arago point rises on the opposite sky As the sun sinks lower, the Arago point rises higher, and when the sun sets the Babinet point and the Arago point are both at an equal elevation of about 20° above the horizon

As we have stated, points of zero polarization occur only on the principal meridian At the points analogous to the neutral points on the other meridians, the *sign* of the polarization changes, this depends on whether I_l is greater than or less than I_r The polarization is assumed positive if I_l is less than I_r and negative if the reverse is true On this convention the polarization is negative on the principal meridian between the Babinet and the Brewster points, outside these points the polarization is positive Thus on the principal meridian the Babinet and the Brewster points separate the regions of positive from the regions of negative polarization The neutral lines do the same for the entire hemisphere

The neutral lines have been observed most carefully by Dorno[1], and the diagram representing his principal results is reproduced in Fig 2 It will be seen from this figure that when the sun is nearly on the horizon the neutral line connects the Babinet and the Arago points by a closed symmetrical curve of the shape of a lemniscate[22] As the sun rises this lemniscate becomes more and more asymmetrical, and when the angle of incidence exceeds 68° the lemniscate opens out and a part of the locus appears on the horizon below the sun and passes through the Brewster point which has now risen The neutral line consists of two such separated curves until the angle of incidence becomes about 44°, when the two ends meet and we have again a closed re-entrant curve For still smaller angles of incidence the neutral line 'collapses' towards the centre and finally reduces to a point when the sun is at the zenith

The neutral lines computed with the aid of the formulæ we have given for various positions of the sun (which roughly correspond to Dorno's observational curves) are illustrated in Fig 3 It is seen that all the features exhibited by the observations are faithfully reproduced by the theoretical curves

Turning next to the degree of polarization, we have illustrated in Fig 4 its variation on the principal meridian for various angles of incidence It will be noticed that the maximum polarization always occurs in a direction which is very nearly at right-angles to the incident direction In the absence of ground corrections, the maximum polarization is about 90 per cent and is very nearly independent of the altitude of the sun, though there is a slight increase for high altitudes However, when the correction for reflexion by the ground is made, the maximum polarization decreases with increasing altitude of the sun in a quite pronounced manner The observations do show such a behaviour, and we conclude that this trend is due to reflexion by the ground

Finally, in Fig 5 we have compared the degree of polarization at the zenith for various angles of incidence with the observations of Tichanowsky[23] It will be seen that the observed polarizations are systematically lower than the predicted ones even

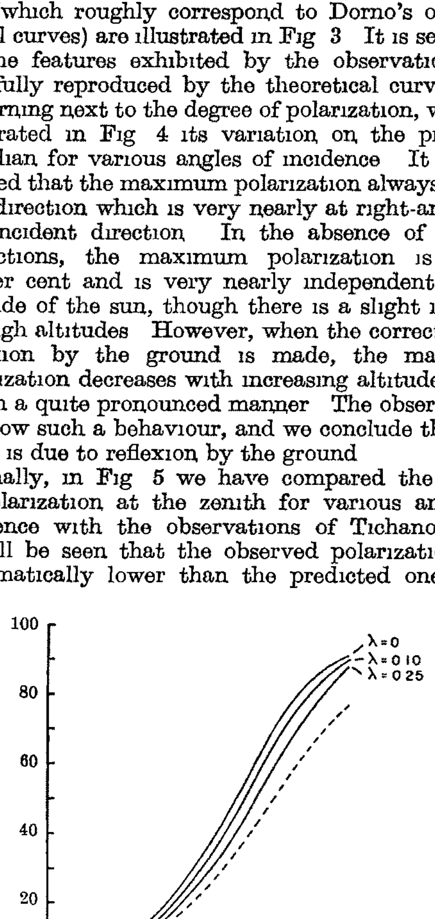

Fig 5 Variation of the degree of polarization at the zenith for various angles of incidence The curve λ = 0 allows for no ground reflexion The other two curves allow for reflexion by a ground with the albedos indicated The dashed curve represents the observations of Tichanowsky

for a ground reflecting with an albedo as high as 25 per cent This discrepancy must clearly be due to the scattering by suspended dust and particles. This last reference to the scattering by particles suggests that, since we now have an exact theory for determining the molecular component of the sky radiation, we have a means of analysing the non-molecular component of the sky radiation

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[21] By an unfortunate error in the numerical calculations, the contrary statements made in ' Radiative Transfer", p 282, are incorrect, the two diagrams on the right-hand side of Fig 28 on p 284 are therefore to be ignored

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SCIENTIFIC RESEARCH IN BRITISH COLONIES

"COLONIAL Research 1949–50"* is an omnibus work which includes, besides the annual report of the Colonial Research Council, the seventh annual report of the Colonial Products Research Council, the sixth annual report of the Colonial Social Science Research Council, the fifth annual reports of the Colonial Medical Research Committee and the Committee for Colonial Agricultural, Animal Health and Forestry Research and the third annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and the Colonial Economic Research Committee Its 155 pages constitute a record of research which bids fair to become wellnigh as impressive as that in the annual reports of the Department of Scientific and Industrial Research , nevertheless, in spite of information regarding staff and publications, "Colonial Research" in its present form still falls far short of being the reference work that the annual report of the Department of Scientific and Industrial Research now provides

Some of the information appended to the annual report of the Colonial Research Council duplicates that already published in Colonial 107 in the return of schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies Disbursements for the year were well over £1½ million, bringing the total sum allocated for research schemes from Colonial Development and Welfare funds since 1940 to about £7¼ million net, to which must be added something like a further £1¾ million additional assistance provided by Colonial governments About 32 5 per cent of the total allocation has been for agricultural, veterinary and forestry schemes, 14 4 per cent for medical research, 14 0 per cent for fisheries research, 8 7 per cent for social science and economic research, 7 6 per cent for tsetse and trypanosomiasis research, 6 5 per cent for insecticides research, 4 6 per cent for Colonial products research, 4 1 per cent for anti-locust research and 7 6 per cent for other miscellaneous purposes Important schemes made during the year include provision for expanding and maintaining for five years the former Rockefeller Yellow Fever Institutes at Lagos, in Nigeria, and at Entebbe, in Uganda, which were taken over as a British responsibility on January 1, 1950, and will in future deal with all virus diseases affecting West and East Africa, respectively , provision for the maintenance for five years of the Institute for Research and Training in Fish Farming at Penang, in Malaya, and the establishment of an East African Marine Fisheries Research Station in Zanzibar, and of a Fisheries Research Station at Fort Roseberry in Northern Rhodesia to serve that territory and Nyasaland

The recruitment of scientific workers, especially the younger men, showed a definite improvement during the year, which witnessed the introduction of the Colonial Research Service , and the Colonial Research Studentship Schemes, notably those in soil science and fisheries, attracted a considerable field of candidates and should lead to many useful research workers being secured for service in the Colonial Empire Reference is also made to the promotion of co-operation between Colonial governments and the Department of Scientific and Industrial Research, particularly in building, road and water pollution research and with the Pest Infestation Laboratory Further research was undertaken during the year by the African Studies Branch of the Colonial Office into the contemporary history and problems of African administration, while Lord Hailey has now completed his survey of African native administration and the organization of native courts The Colonial Local Government Advisory Panel has been of great assistance to Colonial governments, and the work of the regional anti-locust organizations in Africa, administered and financed on an international basis, is developing steadily The second volume of the late Dr Kuczynski's Colonial Demographic Survey, covering East Africa, the South African High Commission Territories, Mauritius and Seychelles, was issued during the year, while the Crown Agents' Engineering Advisory Service continued to furnish technical information to visiting Colonial officials and in reply to inquiries from the Colonies

The Mauritius–Seychelles Fisheries Survey ended in December 1949, the final results of the Gulf of Aden Fisheries Survey have now come in and a first report on the Fisheries Survey in Sarawak has been received The work of the Directorate of Colonial (Geodetic and Topographic) Surveys was again directed chiefly to the preparation of maps of specific areas scheduled for immediate development, but some progress has been made in the preparation of standard topographical series Recruitment of geologists improved very considerably, and besides the expansion of the existing geological surveys in Kenya, Uganda, Tanganyika, Nyasaland, Nigeria, the Gold Coast, Sierra Leone and British Guiana, new surveys were formed in Jamaica and in the British territories in Borneo. The Tsetse Fly and Trypanosomiasis Committee has been reconstituted with the following terms of reference: "To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis", and during the year forty correspondents with the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research were nominated by Colonial governments.

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* Colonial Office Colonial Research, 1949–50 Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides, Fungicides and Herbicides Committee, Colonial Economic Research Committee (Cmd 8063) Pp 155 (London H M Stationery Office, 1950) 3*s* 6*d* net

The report of the Colonial Products Research Council is in two parts—a general report and a most interesting review of some research work in progress. The former refers to the important observation made during the year that banana plants resistant to attack by *Fusarium oxysporum cubense*, the cause of Panama disease, harbour in their root system certain bacteria, which produce antibiotic substances highly active against fungi and other micro-organisms. In the root systems of the Panama disease-susceptible Gros Michel variety of banana, such bacteria are apparently absent or very rare. Following further work by Dr. A. C. Thaysen and his collaborators, Drs. Arnstein, Cook and Lacy, working in the Imperial College of Science and Technology, London, have found that the actinomycete toxic to *Fusarium oxysporum cubense*, isolated from a Jamaican soil, gave a mixture of pigmented strains, and from the fluid culture of the red strain an antibiotic, musarin, was isolated which is a powerful anti-fungal agent but less effective as an antibacterial antibiotic. Working in the University College of the West Indies, Prof. C. H. Hassall and Miss L. Wong have separated seven strains from Meredith's actinomycete, from one of which they have isolated an antibiotic differing completely in its properties from musarin, and which has been designated manamycin. Dr. L. F. Wiggins's synthesis of the cyclic ketonic acid, 2-acetyl*cyclo*hex-4-one-1-carboxylic acid by condensation of butadiene and β-acetylacrylic acid is of special interest as providing an example of the conversion of sucrose derivatives into a homocyclic compound and thus facilitating the industrial utilization of sugar. The properties of sugar cane waxes are being carefully studied, and, in Prof. M. Stacey's laboratory at the University of Birmingham, Mrs. C. E. M. Tatlow has continued to study new trifluoroacetyl derivatives of the sugars. The dextran blood-plasma substitute is now being marketed under the name 'Intradex', and Prof. Stacey is investigating a number of new problems, notably the optimum molecular size of the degraded dextran for transfusion. At the University College of North Wales, Prof. S. Peat has developed comparatively simple methods for producing high-quality amylose and amylopectin from potato starch. Work carried out during the year at the Colonial Microbiological Research Institute has given a general picture of the types of micro-organisms which are active during the fermentation of the cocoa bean in Trinidad and Grenada, and has shown the complexity of the problem of the nature of the substance or substances responsible for the development of the chocolate aroma in fermented cocoa beans. Investigations on the polyphenolic substances in fresh and fermented cacao beans have been extended. Prof. T. P. Hilditch and his collaborators have continued the investigation of vegetable drying oils and have proved that heat treatment of the oil seeds from *Tetracarpidium conophorum* prevents the development of free fatty acid in the seeds on storage, while further technical trials have established the superiority of this oil to linseed oil. Oils from various varieties of groundnuts and sunflower seeds grown in East Africa have been examined at the request of the Overseas Food Corporation. Dr. J. C. Smith and Mr. C. Pickering have further investigated the wetting agents obtained from certain hydrocarbons present in Trinidad petroleum, while the study of the chemistry of eugenol has been continued in Prof. G. R. Clemo's laboratory. Some progress has been made in the study of the saponin isolated from the wood of *Mora excelsa*, and the Council has supported the study of plant materials of potential medicinal or insecticidal value.

The sixth annual report of the Colonial Social Science Research Council refers to the particular attention given during the year to the staffing of regional institutes and to their relation with Colonial universities, to the further employment of sociologists and other workers who have become accustomed to Colonial conditions and to the fullest possible utilization of the experience of research workers. Progress has been made in the establishment of the Institute of Social and Economic Research attached to the University College of the West Indies, and Dr. Audrey Richards has been appointed director of the East African Institute of Social Research, the programme of which for the next five years will be concentrated on linguistic studies, basic ethnographical studies recommended in reports on social research needs prepared for the Council, the utilization of these basic studies in a comparative study of local government, and an urban survey of Jinja and its periphery. Building on a modest scale should start shortly. The new Colonial universities are beginning to be in a position to sponsor research in the social sciences, while among projects in progress may be mentioned the ethnographical survey of Africa, a handbook of African languages, the socio-economic surveys of Zaria (Nigeria), Mba-Ise, Owerri (Nigeria) and Oshogbo (Nigeria), psychological testing in Nigeria, studies of the political organization of typical communities in the Gambia and sociological research at Genieri (Gambia), and anthropological studies of the Turkana (Kenya), the Acoli, Lugbara and the Alur and Jonam (Uganda), and also sociological studies in North Borneo and Singapore.

The fifth annual report of the Colonial Medical Research Committee, besides the continuance of all the main research schemes initiated or supported by the Committee during 1948–49, records the initiation of new investigations of leprosy, particularly in relation to the use of the sulphone group of drugs, and of loiasis, as well as the strengthening of the filariasis unit at Mwanza, Tanganyika Territory. The East African Medical Survey has been transferred to Mwanza from Malza, and in Jamaica a study of the infectivity and habits of the suspected malaria vectors, particularly in relation to housing, and the possibility of control by residual insecticides has been initiated. The East African Malaria Unit was established with headquarters at Muleza, Tanganyika, and arrangements for taking over the research laboratory at Freetown, Sierra Leone, were completed during the year. Following preliminary therapeutic trials which showed that African subjects with bancroftian filariasis tolerated much higher doses of 'Hetrazan' than the level of 2 mgm./kgm. usually employed elsewhere, in prolonged courses, the toxicity of 'Hetrazan' was tested on two hundred Africans free from filariasis and it was concluded that doses considerably higher than those usually employed could safely be given. Extensive surveys have been made of the incidence of infection of *L. loa* and other filarial infections both in human beings and in *Chrysops*, the vector species, in the Kumba and Bamenda divisions in the Cameroons and elsewhere, and the wide distribution of *Chrysops* in Africa has been noted, including its presence in areas where loiasis is not a problem.

A disturbing development in malaria therapy in Malaya has been the appearance of proguanil-resistant strains of *P. falciparum*. The Hot Climate Physiology Laboratory at Oshodi, Nigeria, has been completed and equipped, and studies have been made on the ability of native-born West Africans to work in severe heat and humidity, the effect of arterial occlusion upon the sweat rate and sweat composition, the metabolic costs of common tasks, blood chemistry and daily sweat loss in routine tasks. Physiological research at Makerere College, Uganda, has included red blood cell counts of students and the preparation of precipitin sera; investigations have been carried out of tick-borne relapsing fever, and the success of chloromycetin in the treatment of scrub typhus has been amply confirmed. A field research unit based on the Institute for Medical Research, Kuala Lumpur, Malaya, is making a long-term study of scrub typhus.

The fifth annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research reviews the regional agricultural research, as under the East African Agricultural and Forestry Research Organization, where work is being done in mycology, including a study of the canker disease of cypresses, and where absence of staff has impeded the research into the sudden death disease of the clove trees. The individual research projects are assisted from Colonial Development and Welfare Funds and research work is undertaken as part of the programme of Colonial departments. Under the banana research scheme administered by the Imperial College of Tropical Agriculture, Trinidad, work on the breeding of male parents carrying the factors of immunity to Panama disease has reached a stage at which little further progress can be made until the projected expedition to south-east Asia can take place; and under the cocoa research scheme, similarly administered, work is proceeding on the completion of testing the I.C.S. clones, the establishment of a collection of cacao types, of *Theobroma* species and allied types, and breeding of improved strains, including those resistant to witches broom. Individual research projects include the appointment of an officer in charge of termite research in the Colonies to study termites in the field and train entomologists for this specialized work, in the first place in East Africa. In British Guiana manurial research in progress aims at the solution of the phosphate problem, while in the Federation of Malaya mechanical cultivation trials of rice received special consideration. On the Gold Coast, research into lime die-back disease has shown that a virus is responsible, that most sweet citrus is capable of carrying it and that *Aphis citricidus* Kirkaldy (*A. tavaresi* del Guercio) is one of the vectors. In Mauritius, research is being carried out to find means of controlling or eradicating the introduced shrub *Cordia macrostachya* (Jacq.), which is a serious weed in sugar plantations; also clonal selection trials are in progress at the Lyamunga Coffee Research Station, Tanganyika. Reports are also included from the standing Cocoa Research, Soils and Stored Products Sub-Committees.

The Colonial Insecticides, Fungicides and Herbicides Committee appointed two new sub-committees during the year, one to consider problems relating to herbicides and arboricides (including defoliants) and the other to deal with defoliants. Arrangements have been made with the Imperial College of Science and Technology, London, and the Agricultural Research Council for fundamental work on insecticides to be conducted at the Imperial College Field Station, Silwood Park, and at Rothamsted Experimental Station. Preliminary work on a number of the newer insecticides has been agreed on, and the establishment of a Colonial Insecticides Research Unit in West Africa is recommended. A study of the behaviour of mosquitoes in huts treated with DDT and BHC has commenced, and also of the effect of partial defoliation of the bush in tsetse concentration areas on tsetse control and the disinfestation of trains against tsetse. The work of the Colonial Insecticides Research Team, Porton, on aqueous suspensions of insecticides, the formation and properties of DDT crystals, the toxicity of compound 497, 'Chlordan' and 'Toxaphene', and the fumigant action of insecticides, and that of the Colonial Insecticides Research Unit, East Africa, on tsetse, mosquitoes and malaria, and malaria eradication in Mauritius are reviewed in some detail.

The third annual report of the Colonial Economic Research Committee records that arrangements for research projects into the national income of Nigeria, the problems arising from the dependence of certain Colonial territories upon imported foods and on transport economics in relation to economic development, with special reference to Nigeria, are well under way; difficulty in securing suitable research workers has continued to be a principal hindrance to progress. Other schemes in progress at the end of the year were Dr. J. Greaves's inquiry into Colonial monetary systems, and an investigation by Mr. P. T. Bauer of the organization of trade in West Africa.

FIFTIETH ANNIVERSARY OF THE NOBEL FOUNDATION

ON December 10, the Nobel Foundation celebrated its fiftieth anniversary. Alfred Nobel, a man of great vision and unique generosity, and most keenly interested in the welfare of mankind, wished his discovery of dynamite, the most potent explosive of his time, and the huge estate collected through its manufacture, to benefit peace and progress. To achieve this he directed that his estate after his death should constitute a fund, the interest of which would be distributed annually in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind. The interest was to be divided into five equal parts, and apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature the most outstanding work of an idealistic tendency; and one part to the person who shall have done the most or the best work for fraternity among nations, for the abolition or reduction of standing armies and for the promotion of peace.

The prizes for physics and chemistry were to be awarded by the Swedish Academy of Science; that for physiology or medical work by the Caroline Institute in Stockholm; that for literature by the Academy in Stockholm; and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting.

Nobel added that it was his wish that in awarding the prizes no consideration whatever should be given to the nationality of the candidates, so that the most worthy should receive the prize, whether he be a Scandinavian or not. Later it was realized that in practice a prize could not be awarded for work done during the preceding year only. The rules of the Nobel Foundation were correspondingly amended, stating that the provision in the will that the annual award of prizes shall refer to work during the preceding year shall be understood in the sense that the awards shall be made for the most recent achievements in the fields of culture referred to in the will, and for older works only if their significance has not become apparent until recently.

In his contribution to a volume just published, entitled "Nobel: The Man and His Prizes" (Stockholm: Sohlmans Forlag), Liljestrand, who for the past thirty-two years has filled the important post of secretary of the Medical Nobel Committee, emphasizes the marked similarity between certain expressions in Nobel's will and the regulations governing the Rumford Medal, which is awarded by the Royal Society in London "to the author of the most important discovery or useful improvement ... made during the preceding two years on heat or light, the preference always being given to such discoveries as ... tend most to promote the good of mankind". It seems probable that these directives served as a model for Nobel when he began to plan his awards for new and important contributions to human welfare in certain scientific or other cultural fields.

Competence to submit proposals for the award of Nobel Prizes for Physics and Chemistry is enjoyed by: (1) Swedish and foreign members of the Royal Academy of Science; (2) members of the Nobel Committees for Physics and Chemistry; (3) men of science who have been awarded a Nobel Prize by the Academy of Science; (4) professors of physics and chemistry in several Scandinavian universities; (5) holders of corresponding chairs in at least six universities or corresponding institutions selected by the Academy of Science with the view of ensuring the appropriate distribution of the commission over the different countries and their seats of learning; and (6) other men of science from whom the Academy may see fit to invite proposals, an authorization of which the Academy makes use on generous lines.

Competence to submit proposals for the award of the Nobel Prize for Physiology and Medicine is enjoyed by: (1) members of the teaching body of the Caroline Institute; (2) members of the medical class of the Royal Academy of Science; (3) previous recipients of the Nobel Prize for Physiology and Medicine; (4) members of medical faculties of several Scandinavian universities; all the bodies which are named above under (5) and (6).

That good use is made of these generous competence statutes of the Nobel Foundation is shown by the fact that in the course of the past fifty years as many as 872 names have been suggested as recipients of the Nobel Prize for Physiology and Medicine alone.

While the ultimate responsibility for the distribution of the Prize for Physics and that for Chemistry lies with the Swedish Academy of Sciences and for the Prize for Physiology and Medicine with the Caroline Institute (Medical Faculty), much of the responsibility is borne by the special committees appointed to advise these institutions. The members of these committees carry out a heavy and difficult task in scrutinizing the large number of proposals submitted. In 1950 the number of nominations for the Prizes for Physics, Chemistry and Physiology and Medicine were as high as 56, 72 and 113 respectively.

General merit alone in promoting science does not qualify for obtaining a Nobel Prize. Several contributions by the same person but in different fields, none of which is important enough by itself to qualify for an award, are not considered. It is after recognizing the fundamental importance of a discovery that it is ascertained who is or are responsible for that qualifying advance. The statutes of the Nobel Foundation thus do not exclude the possibility of one person obtaining more than one Nobel Prize.

However, only one Nobel laureate has so far obtained more than one prize; that was Marie Curie, who received one and a quarter awards. The Physics Prize in 1903 was shared by Becquerel and by Pierre and Marie Curie, half of the prize being allotted to Becquerel. In 1911 the Chemistry Prize was very appropriately awarded to Marie Curie, "for her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element". As Irene Joliot-Curie and Frederic Joliot obtained the Chemistry Prize in 1935 "for their synthesis of new radioactive elements", the Curie family has received no less than five Nobel Medals, which may remain a record for all time.

The history of the Nobel Foundation covers much of the history of physics, chemistry and medicine of the past fifty years.

The awarding institutions very happily chose Rontgen as the first recipient of the Physics Prize, while Van't Hoff and von Behring were given the Prizes for Chemistry and Medicine. In the history of science, few discoveries have put into motion an avalanche as mighty as did Rontgen's, leading from Becquerel's fundamental observation to the discovery of radium and to the birth of nuclear sciences so intimately connected with the name of Rutherford. There is no branch of science that has not benefited from the discovery of X-rays.

The presentation of Nobel Prizes is always a great and solemn event. This year, the fiftieth anniversary of the Foundation, has been marked by even greater ceremony.

All former laureates were invited to attend; twenty-five came from abroad to join their five Swedish colleagues in celebrating this most happy event. They were headed by Max von Laue, who received the Physics Prize in 1914 for his discovery of the diffraction of X-rays by crystals, a work which immensely accelerated the rate of motion of the avalanche released by Rontgen's discovery.

In the beautifully decorated Hall of the Academy of Music, H.M. King Gustav handed over the Physics

Prize to Powell, the Chemistry Prize to Alder and Diels, and the Prize for Physiology and Medicine to Hensch, Kendall and Reichstein.

Dr Österling, when addressing Bertrand Russell at that occasion on behalf of the Swedish Academy of Literature, pointed out that Russell's philosophy may be said in the best sense to fulfil just those desires and intentions that Alfred Nobel had in mind when he instituted his prizes There exist quite striking similarities between their outlooks on life Both of them are at the same time sceptics and utopians, both take the gloomy view of the contemporary world, yet both hold fast to a belief in the possibility of achieving logical standards for human behaviour

During the banquet in Stockholm's splendid Town Hall which followed the presentation, tribute was paid to Alfred Nobel's memory and also to the achievements of the present and former laureates It was emphasized that the great attendance at the fiftieth anniversary ceremonies is a sign of the high esteem in which science and literature are held in Sweden, as well as an expression of deep admiration and indebtedness to those who through their brilliant achievements have enriched our minds and contributed to the welfare of human beings

In a world torn by political disunity, the Nobel Foundation, in the spirit of its founder, has always tried to serve the cause of international understanding Let us hope and trust that this spirit will prevail in the times to come G HEVESY

OBITUARIES

Prof. W. Kosters

PROF WILHELM KOSTERS, president of the Physikalisch-Technische Anstalt at Brunswick in Western Germany, died suddenly at Munster, in Westphalia, on July 28, 1950, at the age of seventy-four With his death the science of metrology loses one of its most energetic and experienced workers

Wilhelm Kosters was born on April 25, 1876 He studied physics, mathematics, chemistry and mineralogy at the Universities of Munster, Greiswald and Bonn His first appointment after graduating as Dr phil in 1899 was with the Kaiserliche Normaleichungskommission (Standards Committee), which later became the Reichsanstalt fur Mass und Gewicht When this establishment was amalgamated in 1917 with the Physikalisch-Technische Reichsanstalt, Kosters became director of the Department for Weights and Measures and was head of the Laboratory Between 1899 and 1917, Kosters was scientifically active in all the Laboratories of the Committee and at an early age made valuable contributions to the methods of metrological observation and instrumentation, his contribution to the development of the larger comparator was a decisive factor in influencing subsequent measuring technique of the German length standard In 1917 he was appointed head of the laboratory dealing with length standards

In 1892, in Sèvres, Michelson compared the metre with the wave-length of the red cadmium line Fabry and Perot in 1907 made a check comparison and obtained a result which was within one ten-millionth of Michelson's result Following these measurements, the opinion prevailed in metrological circles that a wave-length of a particular monochromatic light could be used instead of the international metre standard, and Kosters was a pioneer in the application of wave-length measurements for determining standard length He saw the advantage to industry in the use of interference measuring methods, and his work resulted in 1920 in the Kosters's interference comparator built by Carl Zeiss, of Jena, and which, by its universal application, has in no mean way contributed to the fact that German industry in the field of metrology holds the position it does to-day

In 1921 Kosters was elected a member of the Comité International des Poids et Mesures, and here he successfully advocated the use of a wave-length as a measure of standard length, at the seventh conference, held in 1927, it was decided provisionally that the metre was equivalent to 1,553,164 13 times the wave-length of the red line of cadmium in dry air at 15° C, at a pressure of 760 mm mercury and $g = 980\ 665$ cm sec^{-2} Kosters's definition of standard gauge length was accepted internationally and, at his proposal, the yellow-green krypton line ($\lambda = 0\ 565\ \mu$) was accepted as the wave-length standard Under Kosters's leadership this line was selected as it was found to be reproducible with the required degree of accuracy, and, indeed, at the time of his death, Kosters was still experimenting in this field using krypton-84 and -86

The results of Kosters's scientific work led to improvements and developments in a great number of applications the development of standard lamps for the interference method of measuring length (1928), investigations on the Doppler spread of the lines of the spectrum and experiments in the cooling of lamps with solid nitrogen (1938), development of the interference double prism (1931), determination of the constituents of sea water by interference methods (1930), development of a comparator for the measurement of the International Ohm (1935), work on the precision measurement of the refractive index of glass plates by the interference method (1940), introduction of a standard temperature of 20° C for industrial measuring purposes, which Kosters considered specially important and which was adopted by the International Committee for Weight and Measure at Paris in 1939

In 1948 Prof Kosters was appointed the first president of the Physikalisch-Technische Anstalt, Brunswick (now renamed Physikalisch-Technische Bundesanstalt), which is the successor of the Physikalisch-Technische Reichsanstalt formerly situated in Berlin-Charlottenburg He carried out the very difficult executive tasks of rehabilitating the Physikalisch-Technische Anstalt in its new surroundings at Brunswick during the critical and trying post-war period in an able manner, and his loss will be doubly felt, first, because he was an able executive, and secondly, because the load of executive duties prevented him from completing the metrological work for which he was so well known It is characteristic of the man that he was not a writer of books, once a scientific problem on which he had been engaged extensively was resolved, his interest in that problem was finished, and perhaps through this he may be known only to the specialists, since he leaves behind remarkably little published scientific work E KORNATZ

Prof W T Gordon

PROF W. T. GORDON, emeritus professor of geology in the University of London, died on December 12 at the age of sixty-six after a very short period of retirement

He graduated at Edinburgh, and after a period of research at Cambridge returned to his University as lecturer in palæontology under Prof James Geikie In 1914 he was appointed lecturer in geology at King's College, London, taking charge of what was then quite a small department He maintained it during the First World War, and in the succeeding phase of expansion his vigour and organizing ability developed it so considerably that the title of professor of geology was conferred on him in 1921 He occupied the chair for twenty-seven years

During these earlier years, Prof Gordon laid the foundations of his notable work on the Lower Carboniferous flora His name will always be associated with two famous localities for petrified fossil plants on the shores of the Firth of Forth, Pettycur and Gullane He developed the interesting and important theory that favourable opportunities for such petrifactions were found in the vicinity of freshly deposited beds of volcanic ash subjected to contemporary weathering, and he successfully applied this theory in guiding his field collection He published detailed accounts of a number of important species One of his most important contributions was the collection of complete material for the description of the genus *Pitys*, published in 1935 His interests also ranged widely in the field of invertebrate palæontology, and he made an important addition to our knowledge of the rather enigmatical group of the Archæocyathinæ based on material from Antarctica Further, though he published little on the mineralogical side of his subject, he had wide knowledge of the gemstones, particularly of the diamond he was active as a consultant in this field for the greater part of his working life

Prof Gordon served as secretary and vice-president of the Geological Society of London, as president of Section C (Geology) of the British Association at the Aberdeen meeting and he was active in the work of many other societies It is much more difficult to express in short compass any adequate appreciation of his services to his College and University He was a real friend to the students of King's College and a notable teacher of his subject Old students of his are at present serving as heads of three of the Schools of Geology in the University of London, including his own He did much also to develop the teaching of engineering geology and geography at King's College But his memory will live in the minds of many who never entered his Department, for his strength of character and great personal charm made him a notable figure in the general College life, and he gave freely of his abounding energy and vitality of mind to a wide circle both within and beyond the College walls

S. W **Wooldridge**

We regret to announce the following deaths

Lieut -Colonel J P Mead, C B E , formerly directo of forestry in Malaya, on January 2, aged sixty-four

Mr W F Perree, C I E , during 1919–25 chie conservator of forests and president of the Fores Research Institute, Dehra Dun, on December 6 aged seventy-nine.

NEWS and VIEWS

Theoretical Physics at King's College, Newcastle upon Tyne: Prof. G S Rushbrooke

Dr G S Rushbrooke has been appointed as from next September to the chair of theoretical physics at King's College, Newcastle upon Tyne, which replaces that of experimental physics occupied by Prof G W Todd until his death in February 1950 Dr Rushbrooke studied at Cambridge, gaining first classes in Parts I and II and a distinction in Part III of the Mathematical Tripos, and several prizes After graduating, in 1936, he worked first with R H Fowler on statistical theory, and was awarded the Rayleigh Prize for an essay on the theory of solutions, in 1938 He proceeded to the Ph D degree in 1940, after having spent a year as research assistant to Prof N F Mott at Bristol He then moved to University College, Dundee, where he worked first in the Department of Mathematics and afterwards in the Department of Physical Chemistry During these five years he published numerous papers on a variety of subjects, mostly mathematical-chemical in character From 1945 until 1948 he was working chiefly on research problems, in the Departments of Mathematics and Chemistry of the University of Leeds, and he then proceeded to Oxford as senior lecturer in theoretical physics, which post he still holds Dr Rushbrooke has published or collaborated in more than twenty original papers covering a wide field in mathematical physics and chemistry His main interest is in statistical mechanics, and he has written a book on the subject which has been very well received He will be welcomed at Newcastle, not only by the Department of Physics but also by those of mathematics and chemistry

Sir James Cantlie (1851–1926)

To the specialist in tropical diseases, Sir Jame Cantlie, who was born one hundred years ago, o January 17, 1851, is known as the founder of th London School of Tropical Medicine, of the Roya Society of Tropical Medicine and Hygiene, and of th *Journal of Tropical Medicine and Hygiene* The first aid worker remembers him as the creator of th College of Ambulance, the author of popular Re Cross manuals, and the inventor of a bullet-proo ambulance stretcher for rescue work in the trenche while members of the Royal Army Medical Corp recall that his Voluntary Medical Staff Corps was th parent of the Royal Army Medical Corps of th Territorial Army To the layman, Cantlie is th rescuer of Sun Yat Sen, founder of the Chines Republic , the evangelist of 'physical jerks' , autho of "Degeneration amongst Londoners" , the ma who advocated a national society for the preventio of decaying teeth, suggested bringing sea air in pipe from Brighton to London, and attacked the Eto jacket for exposing the loins A versatile ma possessed of infectious vitality and a keen spirit adventure, Cantlie was a fine teacher, an entertainin speaker and writer, and an amusing companion H was a veritable genius for inventing things great an small His many and varied public services have tende to overshadow his contributions to medicine, such his operation for liver abscess, for which he introduce instruments of his own design Cantlie was a graduate the University of Aberdeen and was appointed assista surgeon at Charing Cross Hospital at the youthful ag of twenty-six He was created K B E in 1918 an died on March 28, 1926, in his seventy-fifth year

The Physikalisch-Technische Anstalt

ELSEWHERE in this issue we record the death of Prof W Kosters, the first president of the Physikalisch-Technische Anstalt, which is situated a few miles west of Brunswick in the British Zone, and is successor to the Physikalisch-Technische Reichsanstalt, of Berlin-Charlottenburg During the War, many departments of the Physikalisch-Technische Reichsanstalt had been dispersed to various university towns, the major part to Weida in Thuringia (Russian Zone) Some 80 per cent of its buildings at Charlottenburg were eventually destroyed by bombing Although, therefore, the move to new premises was dictated by necessity, it brought with it many advantages The Physikalisch-Technische Reichsanstalt had outgrown its Charlottenburg premises, and these, being situated in a municipal neighbourhood, had as time went on become increasingly unsuited for delicate scientific measurements Following agreement between the three Western Occupying Powers, the Scientific Research Branch of the British Element of the Control Commission for Germany was made responsible in 1948 for the rehabilitation of most of the departments remaining in Berlin, and the scattered elements elsewhere, as the Physikalisch-Technische Anstalt This was part of the policy of the Scientific Research Branch, of encouraging German research of a peaceful nature as opposed to the main policy of controlling and preventing research for war purposes A site on the old Luftfahrtforschungsanstalt Hermann Goering near Brunswick in Lower Saxony was placed at the disposal of the Physikalisch-Technische Anstalt, on condition that the extensive demilitarization of the buildings with war potential was undertaken The Luftfahrtforschungsanstalt had escaped destruction during the War probably because it is situated in a thick wood and was provided with elaborate camouflage The Deutsche Physikalische Gesellschaften in the British Zone (which at their recent annual meeting held in Bad Nauheim were reconstituted as the Verband der Deutschen Physikalischen Gesellschaften) appointed a committee consisting of Profs Heisenberg, Kopfermann, von Laue and Pohl to advise on the selection of a president, and the choice fell on Kosters Hitherto the policy had always been to recruit the president from outside the Physikalisch-Technische Reichsanstalt

International Standards and Use of Insecticides

THREE subjects are, in the main, dealt with in the report on the first session of the Expert Committee on Insecticides of the World Health Organization (Technical Report Series, No 4, pp 46, Geneva World Health Organization, London H M Stationery Office, 1950, 2*s* 3*d*, 30 cents) The first concerns the specifications of international standards for insecticides and their formulations for use against vectors of malaria, together with specifications for standard spraying equipment for malaria control and its adaptability to regional conditions The second is the elaboration of a standard method for the elimination of insect vectors of disease from ships and aircraft, while the third is the recommendation of measures that might be given general application for the prevention of the introduction of anopheline mosquitoes into areas free or freed from them Detailed specifications are laid down for DDT, together with the methods for determining the required chemical and physical characteristics of technical grade DDT Other insecticides are left in abeyance General requirements for formulations are set out. Specifications for hand and compression sprayers are given in some detail, and technical improvements recommended Methods of 'dis-insection' of ships and aircraft for quarantine purposes are described using DDT and the pyrethrins and the recommendations of the committee on the composition, dosage and forms of distribution of the insecticide in the aircraft are given The measures that, in the opinion of the committee, should be considered in the endeavour to prevent re-introduction of anopheline mosquitoes in an area freed from them are then described Brief consideration is given to the question of the interchange of information and literature, the waiving of customs duties on material for insect control, the functions of the World Health Organization panel of experts on insecticides, the toxicity of DDT to man, and rodenticides

James Young

AN article by A D Cummings in the October 1950 issue of *Discovery* (11, No 10) gives details of how the petroleum industry was started in Great Britain by James Young just over a hundred years ago In 1847 Young received a letter from Lyon Playfair, chemist to the Geological Survey, explaining that a spring of "mineral naptha" had been discovered on an estate near Alfreton, Derbyshire, and inviting Young to develop an industry which would provide a lamp oil cheaper than the sperm oil then in use Young, who was then works manager to a chemical firm in Manchester, invited his employers to promote the project, the idea was considered too trivial to discuss Yet, within twenty years, Young was able to retire with a comfortable fortune and, after several disappointments, was able to launch an industry which is still working profitably An interesting sequel to Playfair's original letter was that no further oil discovery was made in Great Britain until 1918 when a small quantity of oil was discovered near Chesterfield

Taxonomy of Tropical African Plants

SHORTLY before the appearance of the paragraph under this title in *Nature* of December 2, p. 936, the secretary of the Association pour l'Étude taxonomique de la Flore d'Afrique tropicale, Dr J Léonard, tendered his resignation No official Belgian representative was present at the inaugural meeting In consequence of the above resignation a meeting was held at Kew on December 14 to elect a new secretary Twenty-one botanists were present including taxonomists from the Anglo-Egyptian Sudan, Austria, Portugal and the United States of America Letters in support of the aims of the Association had been received from botanists in Belgium, France, Germany, Italy, Nigeria and Sweden By a unanimous vote of those present, Mr R D Meikle, of the Royal Botanic Gardens, Kew was elected secretary, and all communications regarding the Association should be addressed to him

Physical Society's Annual Exhibition

THE thirty-fifth annual Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society will be held during April 6–11, excluding Sunday, in the Royal College of Science Main Building Imperial Institute Road, London, S W 7, and also in the Huxley Building, Exhibition Road (opposite the Science Museum) All tickets will be valid for entry into both buildings The first day will be reserved for members of the Society and the Press only Discourses will be delivered by eminent men of science on four days of the Exhibition, and the prize-winning models of the Society's annual Craftsmanship and Draughtsmanship Competition will be on show A handbook of the Exhibition, containing full descriptions of all exhibits, will be available early in March from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S W 7

Chemical Aspects of Cell Division

The Manchester Section of the Chemical Society, in conjunction with the Institute of Petroleum, the Royal Institute of Chemistry and the Society of Chemical Industry, is holding a symposium in the University of Manchester on March 15 on "Chemical Aspects of Cell Division" The speakers and their subjects are Prof A Haddow, "Recent Developments in the Study of Cytotoxic and Carcinogenic Action", Dr W C J Ross, "Cytotoxic Action in Relation to Chemical Reactivity", Dr F L Rose, "Cytotoxic Action in Relation to Molecular Shape", Prof J N Davidson, "Chemical Components of the Cell", Prof W T Astbury, "The Problem of the Collaboration between Proteins and Nucleic Acids", Dr W M Dale, "The Indirect Action of X-Rays on Aqueous Solutions of Biologically Active Substances, and the Specificity of the Radiation Effects", Prof E C Dodds, "The Application of Biological Research on Hormones, with Special Reference to the Cancer Problem" The chairmen of the three sessions will be Profs A Haddow, J W Cook and E R H Jones Further particulars can be obtained from Dr M A T Rogers, Imperial Chemical Industries, Ltd, Dyestuffs Division, Hexagon House, Blackley, Manchester 9

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced Miss E A Blundell (woman education officer, Kenya), head of science side, Kenya High School, Dr J I Taylor (veterinary research officer, Uganda), chief veterinary research officer, Uganda, J H Haughton (agricultural officer grade 2, Jamaica), senior agricultural officer, Jamaica, H O Walker (meteorologist, East African Meteorological Department, Kenya), senior meteorologist, Nigeria, H B Ambrose, agricultural officer, Kenya, J L Clacey and J T W Gray, agricultural officers, Gold Coast, J F Conroy, agricultural officer, Nyasaland, R M Davis, agricultural engineer, Nigeria, R F Le Duc, agricultural officer, Tanganyika, J D Carter and O L Lewis, geologists, Nigeria, W Manning, geologist, Tanganyika, G R C Morgan, geologist, Federation of Malaya, J B McLean, veterinary officer, Nigeria, E C Clarke and A C A Walker, assistant conservators of forests, British Guiana, A Fraser, assistant conservator of forests, Nigeria, I H Proverbs, livestock officer, Nyasaland

Royal Commission for the Exhibition of 1851

Mr W D Sturch, secretary to the Royal Commission for the Exhibition of 1851, writes "I have read with interest Captain Edgar C Smith's article on 'Scientific Centenaries in 1951' (*Nature*, January 6, p 7), but may I add one small comment He ends his reference to the 1851 Exhibition with these words 'Fortunately, the Exhibition made a handsome profit, a part of which was used to purchase the market gardens to the south of Hyde Park, a tract of land now partly covered by some national museums which will play a part in the Festival of Britain' This is a somewhat summary dismissal of the Science, Geological, Natural History and Victoria and Albert Museums, and it ignores entirely the Imperial College of Science and Technology and the Royal Colleges of Music and Art which are also on the estate Finally, it would perhaps be worth a mention that the present 1851 Senior Studentships and Overseas Scholarships for Scientific Research are still financed out of the Great Exhibition profits"

Announcements

Sir Cyril Hinshelwood, Sir Claude Gibb and Colonel H C Smith have been appointed members of the Scientific Advisory Council of the Minister of Fuel and Power, Dr E S Grumell and Dr H Hollings have retired from the Council

Mr H A R Binney, Under-Secretary at the Board of Trade since 1947, has been appointed director and secretary of the British Standards Institution in succession to the late Mr Percy Good

The following appointments in the University of Birmingham have recently been announced Dr S W Challinor to be lecturer in microbiology in the Department of Industrial Fermentation, W H Husband and E J Charles to be lecturers in chemical engineering

The third residential national conference of the Institution of Works Managers will be held at Southport during April 13–15 The arrangements are being made mainly by a local committee of members drawn from the Manchester and Merseyside branches of the Institution Further information can be obtained from the Institution at 67–68 Chandos Place, London, W C 2

The seventieth annual general meeting of the Society of Chemical Industry will be held during July 9–13 at the Imperial College of Science and Technology, South Kensington, London, S W 7 The theme for this year will be "Water in Industry" The meeting is being organized by the London Section of the Society, under the chairmanship of Dr A C Monkhouse, of the Fuel Research Station Further particulars can be obtained from the honorary secretary, Mr E L Streatfield, at Filtrators, Ltd, 92 Seymour Place, London, W 1

A symposium on molecular structure and spectroscopy, sponsored jointly by the Department of Physics and Astronomy of the Ohio State University and by the Division of Chemical Physics of the American Physical Society, will be held in the Department of Physics, Ohio State University, during June 11–15 The interpretation of molecular spectroscopic data as well as methods of obtaining such data will be discussed, and, in addition, there will be sessions devoted to those phases of spectroscopy which are of current interest Further particulars can be obtained from Prof Harald H Nielsen, Department of Physics, Ohio State University, Columbus 10, Ohio

Prof F E Fritsch and Dr J W. G Lund are preparing a Freshwater Algal Flora of the British Isles They would be glad to hear of any unpublished records or of records published in the proceedings of local natural history societies If the record relates to a rare species or to one new for the British Isles, they would be obliged if material could be sent to Dr J W G Lund, The Ferry House, Far Sawrey, Ambleside, Westmorland.

ECONOMIC DEVELOPMENT IN THE U.S.S.R.

IN the Soviet economic system, planning has pride of place, and indeed the whole financial system is subordinated to planned economic and social development. The State budget and the credit system are utilized to assist in controlling the fulfilment of the tasks set by the economic plans. The consumer, though free to shop where he likes and free to purchase, or not purchase, what is available, can exert no direct pressure to have those goods produced and sold which he desires, since there is no automatic price mechanism or other direct means of consumer guidance to the producer. Though the broad facts are well enough known, it is hard to come by any detailed information about economic developments in the U.S.S.R., because the necessary statistics and economic facts are not made available in official or academic publications in the same way as in Great Britain. Special interest, therefore, is attached to the work being done in the University of Birmingham by the Department of Economics and Institutions of the U.S.S.R. of the Faculty of Commerce and Social Science. This Department of the University publishes "Bulletins on Soviet Economic Development", based on painstaking research and investigation of the available literature, official publications and the press of the U.S.S.R. Bulletins Nos. 3 and 4 (August–September 1950) of Series 1 have now been issued, and these are to be followed by Series 2, which will examine the results of the Post-War Five-Year Plan in all the main branches of the Soviet economy.

In Bulletin No. 3, Dr. Alexander Baykov (head of the Department) and Mr. G. R. Barker make an important contribution on the Soviet financial system, in which they point out that expenditure in financing the development of the national economy is centralized, being effected mainly through the Union budget, whereas social and cultural (that is, education, health and social welfare) expenditure in the main is decentralized. The underlying idea is that social and cultural needs can be served more adequately in a decentralized manner, and therefore funds for these purposes are allocated through the local budgets, despite the fact that more than one-half of this expenditure is provided by allocations from the revenue of the Union and Republican budgets.

The revenue of the State budget is derived in part from the socialized sector of the national economy, and in part directly from the population. In the first category, the main sources of revenue are the turnover tax and deductions from the profits of enterprises. In the second, the largest items are subscriptions to State loans, and taxes and levies on the population. The turnover tax is the most important source of revenue, and it also plays an important part in regulating prices and controlling the financial activities of enterprises. It is calculated as a percentage of the wholesale transfer price of producer's goods or, as with agricultural produce, as a fixed monetary rate on the quantity of the product sold by the wholesale trade. An audit of the returns provides a check on the whole financial position of the enterprise and the degree in which it has fulfilled its production plan. The rate of the tax, which varies from a nominal 0.5 per cent to more than 80 per cent, is used for regulating prices and the profit of the enterprise.

The tax on profits has three main objectives, namely, fiscal, the stimulation of economic efficiency, and control of the productive and financial plans of the enterprises. The tax is paid from the actual profits, whether or not the planned requirements are fulfilled, thus providing an incentive to efficiency. Over-fulfilment of the plan increases, whereas under-fulfilment reduces, the amount available for capital investment, working capital and for bonuses to managerial staff and outstanding workers as well as for expenditure on housing and welfare.

Of the revenue derived directly from the public, the most important item is subscription to State loans. These channel the savings of the public into the State budget and are used as long-term credit for the development of the national economy. Rural workers pay taxes in kind as well as in money—the former by compulsory deliveries of definite amounts of agricultural produce to the State at fixed prices below the market price. Income tax and cultural and housing welfare contributions are progressive and also vary according to the source of the tax-payer's income, being higher on professional men, individual craftsmen and others engaged in private activities than on those employed by State or co-operative enterprises.

The two main items of State budget expenditure, apart from military and ordinary administrative expenses, are on financing the development of the national economy and on social and cultural measures. Grants are allocated from the State budget for financing the development of all branches of the national economy—industry, agriculture, transport, trade, housing, municipal services, etc. Grants for capital expenditure are placed to the account of enterprises in the specialized long-term credit banks, and grants for circulating capital to the current accounts of enterprises in the State Bank, which is the sole banking institution for short-term credit in the U.S.S.R.

During the Second World War, owing to enemy occupation of important agricultural and industrial territories, the income of the State budget was drastically reduced, while expenditure was greatly increased, not only by military requirements but also by the cost of large-scale evacuation of industrial and agricultural equipment and of masses of people from the invaded areas. Production of consumer goods was severely cut down throughout the war years and the production of agriculture also declined sharply. In the earlier years of the War, additional revenue was obtained by a surcharge on income tax and agricultural tax, but later a reorganization took place by which the bulk of the necessary additional taxation was derived from a special war-tax based not on the actual earning of the particular individual but on average incomes within groups, thus providing an incentive to greater work. An important source of revenue was that from State loans. State lotteries were resorted to and voluntary contributions towards the war effort were organized. Despite all expedients, however, the additional revenue was inadequate to compensate for the heavy fall in the proceeds of the turnover tax and deductions from profits. Budget deficits occurred from 1941 until 1943 and were covered by inflationary issues of money. After the end of the War, the turnover tax came to resume its function as the main source of revenue, and the pressure of direct taxation was reduced.

This turnover tax is particularly adapted to the needs of the Soviet economy, and it can, for example, be used for facilitating or hindering the sale of a particular commodity The effects of this tax on commodity prices are discussed in some detail by Mr H. H. Ware in an article in Bulletin 4 entitled "The Function and Formation of Commodity Prices in the U S S R" He points out that, by means of the planned application of this tax, the retail prices of different consumer goods are adjusted to their existing and future planned supplies, relative to the market pressures of consumer demand There is no free consumer choice since only those known consumer desires which meet with official approval are incorporated into production plans Further restrictions on the consumer are seen in the absence of price competition among shops Price competition only takes place in the 'free markets' of the collective-farm peasants, which transact about one-fifth of the rouble volume of all Soviet trade Consumer choice exerts some pressure, however, on retailers, wholesalers, planners and producers in that, if the consumer refuses to buy the commodities at the price offered, the plans go unfulfilled Planned retail prices would be 'too high' relative to demand and supply if the goods failed to sell according to plan, and 'too low' if they sold out so rapidly that they could not be kept in retail stock

During the War, Russia found herself, owing to the scarcity of food and the short supply of consumer goods, in the position of there being "too much money chasing too few goods", and rationing was introduced. Unlike the British system, this was based on differential scales according to the category of the worker and the number of hours worked This is described in an article by Dr Baykov on "Internal Trade", in which he states that it was also possible to buy rationed articles legally, but at much higher prices, on the free *kolkhoz* markets for agricultural products In 1944, the differential system was further expanded and the sale of rationed goods in special State shops in unrestricted quantities was introduced, though the prices were much higher than those of similar goods bought on the ration cards

Rationing was abolished in December 1947 and was accompanied by a monetary reform Unified prices were fixed at which goods could be freely sold by State and co-operative shops

Bulletin 4 also contains an interesting article on Russian railways by Mr H Hunter He states that, in the initial period of industrial expansion which commenced in 1928, the railways proved capable of handling a greatly increased volume of freight traffic without much expansion of the existing facilities By 1932, the total route mileage operated was only 6 per cent more than that of 1928, even though this was the period in which the Turkestan–Siberian route came into operation By that year, however, the railways were finding it impossible to handle all the traffic that was being offered, and in 1935 the State found it necessary to increase allocations of material and labour for the purpose of increasing the capacity of the basic routes on which it was decided to concentrate the traffic This policy of selective improvement resulted in wide disparity between the best and the worst lines of the system The campaign for regional self-sufficiency, which was inaugurated in 1939, has been continued since the War, and there has been much pressure to eliminate cross-haul traffic and to minimize long-distance hauls Road transport is not yet an appreciable factor in Soviet transport, and Mr Hunter considers that its development is likely to be slow because the traffic which is being developed is that connected with the heavy industries

The Bulletins contain a great amount of information and can be recommended to all those who are seeking an objective description of the Soviet economy It is not easy to suggest improvements, but perhaps two points may be mentioned The use of American terminology in some of the articles may prove confusing to British readers, and, since Soviet statistics of any value are so hard to come by, somewhat more care might be exercised in their editing, for example, the word 'milliard' in some of the tables seems to be misprinted for 'millions'

NATIONAL FUEL RESEARCH INSTITUTE OF INDIA

THE National Fuel Research Institute of India, the plans for which were described in *Nature* of March 1, 1947, was opened by the President of the Republic, Dr Rajendra Prasad, on April 22, 1950 Among those present were the Prime Minister, Pandit Jawaharlal Nehru, Sir C V Raman, Sir S S Bhatnagar, Sir J C Ghosh; Sir K S Krishnan, Sir J J Ghandy, Dr J. W McBain, Dr D N Wadia, and the chief inspector of mines, Mr N Barraclough The Governor of Bihar, His Excellency Shri M. S Aney, presided The Institute is situated at Jealgora, near Dhanbad, in the province of Bihar It lies approximately 150 miles north-west of Calcutta, 65 miles north of Jamshedpur, and 5 miles only from the new fertilizer works at Sindri on the Damodar River

The buildings consist of three main blocks, administrative offices, laboratories and technological block, respectively The administrative building is to be connected by further rooms to the main laboratory block At present, they are separated by about fifty yards, while the technological block is two hundred yards away, in order to avoid dust clouds and fumes from the grinding and carbonizing, and other plant, and the like

The Administrative Block faces the main Sindri road, and has a floor area of about 14,000 sq ft It is divided by a central corridor running the full length The rooms immediately near the entrance hall comprise a reception room, telephone exchange, and visitors' sitting room The rooms on the wings are those of the administrative officer and the assistant director, the director's laboratory, the director's office, and director's secretary, the board room, the general office, and the accounts office The above rooms are on the left wing On the right wing lie the rooms for information and statistics, offices for the chief officers of the Coal Survey, a physical laboratory, engineering drawing office, the geology and the map room, and a large library and reading room All the rooms are air-conditioned

The Laboratory Block has a basement, the main floor, and (above) staff common room and lecture room On the roof there is an emergency tank for water supply The front building is due to be connected with the Laboratory Block by a 25-ft covered passage, which enters into the two wings, each about 100 ft long These wing laboratories are planned to house rooms for fundamental research on colloids, chromatography, photo chemistry, hydrocarbon synthesis, electrical and magnetic properties of coal, coal petrography, photography, spectroscopy, X-rays, gas research, microanalysis, the testing of tars, and research into liquid fuels.

The existing block contains ten laboratories. In the basement are housed the main stores, the air-conditioning plant, a glass-blowing section, photostat room and studio, and the Jharia Coal Survey with its adjoining rooms. On the principal floor are rooms for service stores and standardization, chromatography and photo-chemistry, tar and by-products, inorganic analysis, general coal analysis, liquid fuel synthesis, surface chemistry, gas analysis, calorimetry, and coal constitution. There is a staff writing room. A goods hoist is provided from the basement to the main floor. On the top floor is a large room designed for lectures, conferences, and reading. There is also a canteen for light refreshments. All the rooms are air-conditioned.

The Technological Block is situated at a short distance away, as already mentioned. This arrangement not only makes for cleanliness of the main building, but is also convenient inasmuch as it facilitates the bringing of a railway siding to the Technological Block from the branch line of the Bengal Nagpur Railway, which runs to the south-west of the estate. The Technological Block contains rooms for receiving, weighing and storing coal, and for breaking, grinding, and sampling. A coal-dressing laboratory is also provided. Adjoining the coal-sampling rooms are sections for coal carbonization and the testing of coke, and for studies in fluidization and pneumatic conveying. Another section is devoted to the gasification of coal and the production of oxygen, while the adjoining room is designed for experiments on Fischer–Tropsch synthesis and hydrogenation, the control room being on the verandah side. The remaining sections are allotted to (*a*) instrument making and repair, (*b*) power sub-station, (*c*) general engineering stores, and (*d*) engineering workshop. In the grounds adjoining the Technological Block, pilot plant for different processes such as coal-washing, pulverized fuel, and coal carbonization will be erected.

There is a small block of rooms near the main Technological Block which will serve later as the engineering offices.

Most of the laboratories are on a unit basis, each unit or room, 18 ft × 21 ft., accommodating two research workers. This gives the necessary privacy. Each worker has one central and one side bench. The fume cupboards are large, 14 ft × 3 ft × 6 ft high, and are partitioned to give one section for dangerous or obnoxious fumes, while the other serves as a working bench. The ventilation of the cupboards has been designed to avoid using the conditioned air of the rooms. Each cupboard is provided with water, gas, electricity, compressed air, and vacuum. It is lighted from above by external fluorescent lighting through the reinforced glass top. Consequently, the cupboard is really a working bench for many purposes. The controls of all services are from the front.

The walls dividing the laboratories are comparatively light structures, easily removable, so that, should it be desired to convert two or three rooms into one large laboratory, the change can be effected with ease. The steel-framed windows are large and give adequate light. For artificial illumination tubular fluorescent lighting has been provided, giving an illumination on the benches of 12 foot-candles.

In each research laboratory (except in the basement) there is a double bench in the middle of the room, between the windows, with auxiliary benches against the walls. The framework of the benches carries the service points, which connect with the main services supplies through channels in the floors. Any bench is thus complete with its own services and, if necessary, can be removed by disconnecting at the control points, while another bench is installed with a different layout. Indeed, except for the fume cupboard, which is fixed, the layout of any laboratory can be changed entirely and reconstructed in the course of forty-eight hours, without causing stoppage of work in adjacent rooms.

Balances are provided in some laboratories, but there is also a special balance room in each block, centrally located and suitably lighted.

The laboratory services comprise water, gas, electricity, compressed air, and vacuum. Electric power points are provided in convenient positions at the front of the benches. Control is particularly easy, as the plugs also carry switches. The water, gas, compressed air, and vacuum mains run under the floors of the principal laboratories, and feed each room at convenient and appropriate positions. The large ring-main system of these supplies ensures equal pressure and equal vacuum at each tap. Each laboratory, moreover, can easily be isolated for repairs.

The water supply is from a well 15 ft. in diameter and 120 ft. deep, behind the main Laboratory Block. The water from this well is pumped into a receiver in which the pressure is developed by means of entrapped, and thus compressed, air. There is an automatic device for maintaining the necessary pressure. The system was decided upon in order to effect economy, to give water at a high pressure, and to save the construction of a water-tower.

The waste water from the laboratories passes first by lead pipes at moderately high inclination to cast iron vertical down-comers, and then through open earthenware channels to the drains.

The gas, compressed air, and vacuum plant are housed in the rooms under the outside staircase at the tail-end of the Laboratory Block.

The framework of the laboratory benches is of aluminium alloy tubing, which is light in weight, and simple to assemble and modify. The bench tops are of teak, 1½ in. thick. Cupboard units can be put into position or removed as required. The benches are 2 ft. 10 in. high and 2 ft. 3 in. wide, and there is a clear space of 7 in. under each bench to provide for cleaning and to avoid troubles from dirt, corrosion, rotting, insect pests, and the like. Normally each bench carries two cupboards. This design of bench has proved highly convenient and successful. The central double benches are easily taken to pieces and remade as single benches, and odd sizes can be assembled at short notice. The framework makes it possible to carry the services conveniently, so that only few service points are required on the laboratory walls. For central 'chemical' benches front control of all services is provided.

Organization

The Fuel Research Institute conducts research into the major problems of fuel—solid, liquid and gaseous—and operates the Physical and Chemical Survey of the Coals of India. The object of this Survey is to provide a reliable assessment of the quality and quantity of the resources of the different coals of the country, and to ensure that the different types of coal are utilized to the best advantage—a formidable task

In addition to problems of fundamental and applied research, technical investigations into the sampling and analysis of fuel are also undertaken at the Institute, and pilot plant developed for different processes The following are some of the subjects with which the researches are concerned furnaces, combustion, and boiler plant, high- and low-temperature carbonization, coal-washing, powdered coal, briquetting, gasification, hydrocarbon synthesis, tar hydrogenation, plastics, liquid fuels, internal combustion engine performance, smoke and atmospheric pollution

The main Divisions of the Institute are (1) Coal Survey and Analysis, (2) Carbonization and By-products, (3) Liquid Fuel (including synthetic fuels, petroleum, and substitutes), (4) Physics (including X-rays and spectroscopy), (5) Gaseous Fuels (including gasification), (6) Engineering (including preparation of coal for the market, coal-washing, boiler plant, combustion, engineering, etc), (7) Library and Intelligence, and (8) Administration and Office

At present the headquarters staff consists of the director, assistant directors, and about seventy qualified scientific men, technologists, and engineers

The total cost of the Institute inclusive of buildings, fittings and equipment amounts to Rs 30 lakhs This does not include the cost of the pilot-plant, for which funds are required in the immediate future Pilot-plant is in hand for the following coal carbonization (high- and low-temperature), hydrocarbon synthesis from coal, pulverized fuel investigations, coal-washing, hydrogenation of coal

Programme of Work

The subjects of pressing importance are (*a*) physical and chemical survey of the coals of India, (*b*) blending of coals for coking, (*c*) study of the washability of coals, (*d*) production of oil from coal, (*e*) development and extension of the uses of powdered coal

In order to assess the coal reserves of the country, coal survey laboratories are being established in the chief coalfields, namely, Raniganj, Jharia, Bokaro-Ramgarh-Karanpura, Vindhya Pradesh, Madhya Pradesh, and Assam The staff for these laboratories is first trained at the Institute Each coal survey laboratory has a staff of eight to ten persons under the charge of a senior scientific officer The organization and conduct of the survey involve considerable work and constitute an important part of the activities of the Institute

India has vast supplies of iron ore Her supplies of coking coal are, however, not over-abundant, and researches into the up-grading of coking and caking coals by mechanical coal-cleaning (that is, washing, etc), and into the possibilities of blending for coking are of paramount importance. Tests on coal-washability were started at the instigation of the Fuel Research Committee some years ago, and the Coal Blending and Coking Research Committee at Jamshedpur has done useful pioneer work in the past decade

The chief consumers of coal in India are the railways, which utilize about one-third of the total output of 30 million tons of coal per annum The Fuel Research Institute has for some years co-operated with the Railway Board in its fuel problems, chiefly in an advisory capacity

Regarding mineral oil, India's indigenous annual production is only 7 per cent of the total consumption Many of the above pilot-plant schemes are directly or indirectly concerned with the production of oil fuel Work on low-temperature carbonization, on hydrogenation, and on hydrocarbon synthesis on pilot-plant scale is essential to provide the basic results on which to build commercial plant for the production of liquid fuel

The preparation and utilization of powdered coal are also being studied Investigations into coal and coke breakability and grinding, and into the combustion of pulverized coal under pressure conditions, are in hand The work is connected with the potentialities of coal dust for use in gas-turbines The nature of other researches in hand will be gathered from the list given later

For some three years, work has been carried on in a temporary laboratory at Dhanbad, ten miles away In this laboratory, it has been possible to make a beginning of the physical and chemical survey of the coals of India, to study the washability of many of the seams of the Jharia, Raniganj, Bokaro, and C P coalfields, and to undertake preliminary investigations into the carbonization of Indian coals In addition, attention has been given to manufacturing synthetic oil by the Fischer–Tropsch process, to laying the foundations of sound sampling, analytical, and testing technique, and to training a number of fuel chemists

In addition, several hundred samples of coal have been analysed for their physical and chemical properties, for example, screen analysis, proximate analysis, ultimate analysis (including nitrogen, sulphur and phosphorus), caking index, calorific value For some coals, Gray–King carbonization assays of the coal and the determination of the fusion ranges of the ash have also been done Work has been undertaken for outside parties on a payment basis to the value of approximately Rs 10,000 per annum

At present researches are in hand on the following subjects studies in coal washability and densities of Indian coals, including cleaning of coal by froth flotation and the cyclone washer, coal breakage investigations, pressurized combustion of powdered coal, low-temperature carbonization by various methods, including fluidization, coal constitution investigations, coal-tar investigations for quality, yield, tar-acids, etc, hydrocarbon synthesis studies, studies in surface chemistry and the natural moisture of coals, lignite analyses, including montan wax investigations, coal petrography studies with reference to the reflectance of the vitrains, investigations on sampling and sizing of coals, studies in the flow of air through broken coal and pneumatic conveying of coal, desulphurization of high-sulphur coals, tests on the fusibility of ash of 'clinkering' coals, recovery of cyclopentadiene, styrene, coumarone, indene, etc, from coke-oven gas and tar, cyanogen compounds in coke-oven gas, preparation of ion-exchange compounds from coal, and analytical and other investigations on coal, lignite, coke, mine gases, briquetting, etc

Assistance is given by the Fuel Research Institute in numerous problems of coal utilization to collieries, the Railway Board, Damodar Valley Corporation, Central Electricity Commission, and to central and provincial government departments The field of consultations covers washability of coals, the installation of washeries, coal and coke for the iron and steel industry, synthetic oil developments, pulverized fuels, manufacture of electrode carbons, coking properties of coals, locomotive fuels, coal evaluation, coal dust explosions, lignite developments, briquetting, wood distillation, spontaneous combustion, soft-coke manufacture, mine-air analysis, water analysis, and numerous other similar problems.

A number of publications arising out of work carried out at the Institute have been issued by the director, Dr. J. W. Whitaker, and members of the staff.

MALARIA ERADICATION SCHEME, MAURITIUS

By Dr. M. A. C. DOWLING

Officer-in-Charge

IN the course of a large-scale experiment in malaria eradication in progress in Mauritius, an interesting problem has come to light. In 1948 the Government of Mauritius, in conjunction with the Colonial Insecticides Committee, decided to carry out an experiment with residual insecticide. The aim of the scheme was the eradication of malaria from the island by means, in the first instance, of the application of residual insecticide to the internal surfaces of houses and outbuildings, followed later, if necessary, by auxiliary measures. By this means it was hoped to obtain a clear-cut comparison between the effects of different insecticide formulations, and also to discover whether house-spraying alone was sufficient to produce elimination of domestic *Anopheles* species. Accordingly, a research team was appointed by the Insecticides Committee to direct the experiment and interpret the results, and work began in November 1948.

Mauritius is an island of 720 square miles with a population of some 450,000 persons. Malaria was introduced halfway through the past century, transmitted by the African species, *A. funestus* and *A. gambiæ*. The former mosquito, breeding all the year round, was responsible for a large proportion of malaria cases, whereas *A. gambiæ* flourished only during the hot season, January–May. The first spraying began in the middle of January 1949, and was completed in May. In all, 75,829 houses (including churches, temples, stables, outhouses and other places harbouring mosquitoes were sprayed, representing some 377,000 rooms. A second spraying was carried out during August–December, in which 68,184 houses were sprayed. The insecticide preparations used were DDT in solution in kerosene, DDT wettable powder in aqueous suspension, and BHC wettable powder. BHC was abandoned early in 1950, mainly on economic grounds.

The results so far obtained show a striking reduction in malaria incidence. Two spleen and parasite surveys have been carried out, the first before spraying began and the second during the last six months of 1949. A third survey is in progress, and the figures, although not yet completed, are included in Table 1.

Table 1

Survey	No. of children examined	Spleen-rate %	Parasite-rate %
I Before spraying	3,585	34·8	9·5
II After 1st spraying	12,105	15·3	2·4
III After 2nd spraying (incomplete)	7,724	3·2	0·36

The vital statistics for the island, as would be expected, reflect this diminution in the disease by significant reductions in the total annual death-rate, the infant mortality and the numbers of malaria deaths. A brief summary of these figures is given in Tables 2–5.

Table 2. Total Annual Death-rates, 1934–49

Mean rate, 1934–48 (per 1,000 mid-year population)	27·2 ± 3·37
Range (per 1,000 mid-year population)	20·1–36·1
Annual death-rate for 1949 (per 1,000 mid-year population)	16·6

Table 3. Infant Mortality, 1934–49

Mean rate, 1934–48 (per 1,000 live births)	150·0 ± 19·2
Range, 1934–48	113·9–188·0
Infant mortality-rate for 1949	91·0

Table 4. Malaria Death-rate during the Epidemic First Six Months of Years 1934–50

Mean malaria death-rate, 1934–48 (per 10,000 population)	32·2 ± 8·07
Range, 1934–48	21·0–47·1
Rate (per 10,000 for 1949)	12·9
Rate (per 10,000 for 1950)	4·9

The total death-rate is, however, a more reliable figure than the malaria death-rate, and the first half-year of 1950 shows a significant decrease on previous years.

Table 5. Comparison of Total Death-rates during First Six Months of Years 1934–50 (expressed as rates per annum)

Mean rate, 1934–48 (per 1,000 mid-year population)	28·0 ± 4·22
Range, 1934–48	20·6–38·4
Rate (per 1,000 for 1949)	16·8
Rate (per 1,000 for 1950)	14·7

A further series of figures which provides valuable information regarding the progress of the scheme is the results of examination of children born since the first spraying in their locality had been completed (Table 6). Although only the malarious coastal areas have been included in this survey, the parasite-rate among the children is very low.

Table 6

Age group	Children examined	Positive blood slides	Parasite-rate (%)
0–3 months	1,621	3	0·19
4–6 months	1,619	4	0·25
7–12 months	2,592	7	0·27
Over 1 year	613	1	0·16
Total	6,445	15	0·23

These encouraging figures suggest that the transmission of malaria is of a very low order. This is supported by the fact that the number of cases notified by hospitals and dispensaries as being malaria during the seasonal months January–June of 1950 shows a reduction of 86·0 per cent on the previous record year of 1948. A system is also in operation whereby blood slides are taken by the dispensers from a large proportion of these cases prior to the administration of treatment, and examined in the laboratory for the presence of malaria parasites. Out of 1,700 slides so examined, only 53 (3·1 per cent) were found to be positive. These figures show a very low parasite-rate in spite of a heavy rainfall this summer, suitable in every way for the propagation of mosquitoes. Many of these cases are, no doubt, relapses of the disease.

Since the arrival of the team in November 1948, a careful check has been maintained on the mosquito population, both in adult and larval stages. As the

Anopheles vectors in Mauritius, *A funestus* and *A gambiæ*, are domestic species, their numbers can be demonstrated by catches in human dwelling places, on the walls and ceilings of which the mosquitoes rest after feeding To establish a satisfactory check it was necessary to set up a large number of 'catching stations', nearly 3,500 in all, scattered evenly throughout the island These stations were normal dwellings, representative in type of other houses in the area in which they stood 'Flitted' regularly once a month by trained 'mosquito boys', these catching stations provide a clear index of the effect of residual insecticide on the domestic mosquito species At the same time a detailed search has been carried out regularly both by whole-time skilled personnel and also, in inter-spraying periods, by district staffs, for the breeding places of anopheline larvæ Catches of adult mosquitoes in houses by the routine method mentioned above and also by large-scale 'massed' catching during the year 1949 and the first half of 1950 show a very obvious reduction in numbers after spraying of the two *Anopheles* vector mosquitoes and also of *Aedes ægypti*

Table 7

	Number of houses 'flitted'	*Anopheles gambiæ*	*Anopheles funestus*	*Aedes ægypti*
Before spraying	7,767	2,486	31,196	1,716
After spraying	76,246	703	474	1
Reduction (%)		97 12	99 85	99 94

Considering these figures with the larval and adult findings during the first five months of 1950, two important facts come to light First, *A. funestus*, without doubt the most important carrier of malaria in Mauritius, especially in that it breeds all the year round, has been virtually eliminated since June 1949 With the exception of two small, sparsely populated areas on the coast, this previously very common mosquito can no longer be found, either in adult or larval form A similar effect has been observed on the potential yellow fever vector, *A ægypti* Both these mosquitoes tend to be exclusively domestic in their habits and are apparently not in any way repelled by the residual insecticide on wall surfaces

The second fact of importance is that *A gambiæ*, although apparently (see Table 7) very markedly reduced in numbers by residual spraying, has been breeding profusely all over the island after the heavy rains in March and April 1950 It has already been remarked that malaria transmission is of a very low order, indeed, during the epidemic months of 1950, the number of cases of the disease notified monthly has continued to fall, in spite of the large population of *A gambiæ* A likely explanation of this interesting problem is that *A. gambiæ*, repelled by the insecticide deposits on the walls of dwelling-house and cowsheds, has altered its feeding habits an elected to find outside resting-places A small-scal experiment to illustrate the fact that DDT acts as repellent to this mosquito was recently carried ou Unsprayed houses and cowsheds were not easil available in the coastal area, but one new house an two new cowsheds provided some useful informatio These were 'flitted' at dawn, and sprayed building (DDT wettable powder) nearby were 'flitted' at th same time to act as a control The results are tabu lated in Table 8

Table 8

Type of building	Number of buildings	Mosquito caught	
		A gambiæ	Culicines
I Dwelling-houses (sprayed 8 month previously)	20	1	70
Dwelling-house (new unsprayed)	1	98	59
II Cowsheds (sprayed 6 months previously)	64	6	12
Cowsheds (new unsprayed)	2	531	152

These figures, of course, refer only to a very sma number of buildings, and by themselves are of n value Taken in conjunction with the general malar and entomological situation in Mauritius, howeve they are sufficiently striking to warrant furth investigation This is now being carried out on a larg scale, in order to demonstrate the present feedi habits and resting places of adult *A gambiæ*, and full report will be published at a later date

SWISS SOCIETY OF NATURAL SCIENCES

ANNUAL MEETING

THE Société helvétique des Sciences naturell held its 130th meeting at Davos during Augu 26–28 The Society has met there twice before— 1890, when Davos was becoming one of the gre health resorts of Europe, and in 1929, when it w also one of the great sport centres Between 19 and 1950, Davos has acquired its third role, as highly active and important contributor to scienc beginning with the opening of the Physical-Mete ological Observatory, the present director of whic Dr W Morikofer, was the president of the Socie for the year and secretary of the meeting In sp of the competition of other conferences, the keenne high standards and undefeatable industry of Sw men of science was again remarkably manifest, as w their informed interest in subjects outside their o fields

Prominent among the sectional work was the ve full programme organized by the Société suisse Minéralogie et de Pétrographie to celebrate t twenty-fifth anniversary of its foundation A numb of foreign scientific workers were invited, and fo excursions, each lasting a week, took place bef and after the meeting Prof P Niggli of Berne, in lecture on "Probleme der alpinen Gesteinsmet morphose", explained the need for more precise da from geologists and geophysicists on the timing a sequence of events implicated in alpine rock me morphosis He characterized the effect of variatio in these data by means of a precise techni vocabulary, which was circulated round the la audience in French and German versions, as t present state of the nomenclature appears to chaotic

This lecture by Prof Niggli was the real start the meeting, which was officially opened later in t day by Dr Morikofer in his address "Zur Meteorolo und Meteorobiologie des Alpenfohns" The act physical course of the Fohn phenomenon is n known with fair accuracy, and it is also known th the physiological disturbances so familiar in a la area of Switzerland, and specially marked in Cant

Glaris, are caused not directly by the Föhn itself, but during the preparatory stage, when it blows as a rapid dry wind at mountain-top level, and has not yet been sucked down and become hot by loss of potential energy But much still remains baffling, for example, why the physiological effects are unaffected by obstacles that would screen disturbances in ordinary conditions of pressure, humidity, dust content or electrical state of the atmosphere High-frequency vibrations, such as investigated by Dr Jean Lugeon, might provide an explanation, as they are much more penetrative, but could also be screened by suitable structures Future progress in research on the Föhn requires much closer collaboration between medical and meteorological experts, and much more precise statistical data in both domains

In the section for geophysics, meteorology and astronomy, Dr Lugeon, who is director of the Swiss Weather Bureau, gave a report, entitled "L'espéranto de la stratosphere", of the important international *radio-sonde* trials held at Payerne last May[1] At the same hour, the Swiss Mathematical Society, the Swiss Physical Society and the Swiss Society for the History of Medicine and Natural Science held a joint meeting in honour of the three hundredth anniversary of the death of Descartes On the whole, the occasion was used for stressing Descartes's failure rather than his greatness Dr J O Fleckenstein, of Basle, speaking on "Cartesianische Erkenntnistheorie und mathematische Physik des 17 Jahrhunderts", made clear, above all, Descartes's great mistake in eliminating the time-element from his mechanics

The mathematical section met on its own on the morning of August 27 and began by paying tribute to the memory of Prof R Fueter Dr A Challand, of Berne, in connexion with the problem of bringing sociology into the realm of applied mathematics, suggested extending to sports and examination results a probability technique hitherto applied exclusively to speculations on stock exchanges E Bareiss gave a generalization of Fueter's integral theorem in hypergeometric function theory Mlle Sophie Piccard, of Neuchâtel, summarized her latest discoveries in the search for the bases of the symmetric and alternate groups She was able to enumerate all possible groups generated by a pair of cycles of order 8 forming a connex primitive system, and deduced that a pair of cycles of order 8 is a basis of the symmetric group of order $n > 10$ if, and only if, the pair is connex and primitive The corresponding technique for order 9 and for $n > 9$ gives as a necessary and sufficient condition in that case that the pair be connex A technique for analysing imprimitive systems was then outlined J de Siebenthal added to his published joint work, which extends to non-Abelian subgroups of a compact Lie group, Elie Cartan's theory of the Abelian ones The new work tackles the omitted case of rank 1 Dr L Locher-Ernst established an interpolation formula providing a continuous transition between two correlations in projective geometry Prof H Hadwiger sketched a postulational definition of volume for polytopes, presupposing, as the chairman, Prof F Gonseth, pointed out, a prior definition of translation To conclude, Dr R C H Young spoke on fashions in mathematics, stressing their serious side in research

In the afternoon, all sections joined up for the funicular railway ascent of the Weissfluhjoch The very complex geological panorama was elucidated by Prof J Cadisch, of Berne The Federal Institute for Research on Snow and Avalanches was inspected, with its low-temperature rooms, its thermically tested snowball of about a foot diameter and its stereoscopic microscope showing, in all its perfection, the scintillating branched symmetry of a crystal of snow Afterwards, a film lecture on "Die Metamorphose des Schneekristalls", by Dr M de Quervain, added the dynamic to the static picture, a striking feature being the spontaneous passage to a less symmetrical form with the effect of reducing the surface area Avalanche research was also illustrated by a film, which by a tragic coincidence had caught a skier being engulfed

A symposium was held on "Theorie und Erfahrung" under the chairmanship of Dr M Altwegg, of Zurich It was led by a physicist, Prof M Fierz, of Basle, a psychologist, Dr H Biasch, of Zurich, and the mathematical philosopher, Prof Gonseth The vague word "Erfahrung" (experience) was criticized, no one suggested a definition of the word "Theorie" A sharp difference of opinion showed itself on the question whether mathematics is a science, Prof André Mercier, of Berne, denying this and defining mathematics as the system of all mutually consistent propositions. Prof Gonseth and Prof Fierz opposed him, with the logical proof that such a system does not exist and the practical view that a mathematical theory, like any other scientific theory, is valid only as long as it is not contradicted by 'experience'

At the closing banquet, Dr Mörikofer announced that a Swiss scientific research fund, the first of its kind, is being started under the president of the Société helvétique, Prof A von Muralt

To a small group of members from all sections, perhaps the most interesting experience was the excursion after the meeting to the Swiss National Park in the Engadine, organized by Prof J de Beaumont, president of the Scientific Commission of the National Park and director of the Zoological Museum at Lausanne The Park, which was first instituted in 1929, is now showing results of preservation from human interference not all as expected Gloomier forecasts, in particular, have proved quite wrong there have been no epidemics either in the animal or in the vegetable world The deer have increased to about the limit appropriate to the region, and will presumably be maintained as an equilibrium state by migration across the frontier into Italy, where there is no protection The effect of unrestricted cropping by deer and other wild animals has been to encourage the growth of young trees, by allowing the spread of the fungi that live in symbiosis with them, so that the forest is slowly invading the open spaces Another gradual change, which in some parts may be complete in fifty years time, is the appearance of the Arollo pine wherever humus can settle, supplanting the mountain pine, which grows where the soil is practically absent because of continual shifting of the crumbling dolomite stone Expeditions were curtailed by rain, and only a few animals were seen through binoculars, including, however, some chamois and a magnificently outlined stag on the mountain crest The party also visited the Laboratory of the Scientific Commission of the National Park, built in 1947 at Il Fuorn, at an altitude of more than 6,000 ft, close to the only hotel and private domain in the region

It is fitting to conclude with a few words on the work of the Physical-Meteorological Observatory at Davos, which was on view during the meeting Three main lines of research are of interest. first, the absolute measurement of solar radiation has now reached an accuracy hitherto impossible to achieve, with important results which so far are largely unpublished , secondly, much progress has been made in overcoming the obstacles to the measurement of black-body absorption of solar radiation, notably in estimating or eliminating the adventitious effects of the wind-tunnel installation, set up to counteract the equilibrium disturbances due to small breezes by superposing a known steady wind , thirdly, the energy required to keep a black sphere at 36½° C at atmospheric conditions throughout the day and night is now recorded automatically by an instrument that adds up the hourly totals and the unexpectedly low average obtained goes some way towards explaining the comparative immunity to chills shown by consumptive patients while they remain at Davos, in spite of the severe winters R C H YOUNG

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[1] See Painter, H E , *Weather*, 5, 307 (1950)

ANALYSIS OF HUMAN SKILLS

IN an article in a recent issue of *Occupational Psychology* (14, No 3 , July 1950) Prof C A Mace suggests that what may later be regarded as one of the characteristic features of the twentieth century will be the marked acceleration in the progress of social and human sciences There have been, he says, significant advances in the plan to make a science and an art of human nature—in the growing understanding of basic human skills, of increasing control over human will and in the emergence of a general scientific approach to the study of human emotions and human relations

A fair amount is now known about the basic human skills What is called 'physical' skill, for example, is the ability to produce some required effect or group of effects through bodily movement guided by sensory and perceptual cues There are also intellectual skills in which generalized knowledge and imagination play a more important part, and social skills in which subtle emotional reactions to personality and subtle expression of personality are the chief determinants of the required effect A skill that is employed for æsthetic ends is called an art , one that is turned to industrial ends a craft The clerical and allied occupations involve the practice of some of the simpler intellectual skills The concept of a social skill enters into the analysis of the supervisory functions and into leadership in most of its forms What are called the 'professions' are distinguished not merely by the factor of social prestige but also, as a rule, by a complex intermixture of various types of skill

With the physical skills the apparent simplicity of a skilful movement is always deceptive Many dexterities are dexterities of the hand, and, in consequence, one is apt to speak of skill in terms of co-ordination between hand and eye

The natural tendency to the dominance of the hand is one of the things which needs to be corrected in the acquisition of skill In the very simplest of skills the required effects can be produced only by a sequence of patterns of movements, the components of which are precisely timed and adjusted in relation not only to each other but also to a sequence of patterns in the perceptual cues , the skilled bricklayer invites one to admire not the tapping or the buttering of his bricks but the dance which he performs with his feet

The exercise of skill may become automatic, but it never becomes unconscious Action is always adjusted to perceived cues Skill is at its simplest when signals that are easily perceived call for responses that are easily performed—as when, for example, the typist reads a clearly written script and taps the appropriate keys In the vast majority of cases significant cues have to be singled out from a context of irrelevant information, and in response to these cues new and often difficult movements have to be made In earlier days, even learning to drive a car was a task of this kind Significant and possibly ominous sounds from the engine had to be distinguished from irrelevant 'body' noises, and complex cycles of movement carried out with clutch, gears and brake

Between the physical and the intellectual skills no sharp line can be drawn The greater the complexity of the skill the larger the part played by the higher cognitive functions In all but the simplest skills we may distinguish two factors in cognitive control (1) situational information and (2) general knowledge The exercise of military skill by those at the higher command depends upon these two kinds of knowledge a knowledge of what is happening in particular places at particular times and a knowledge of general principles such as those of strategy, tactics and logistics So it is in all the crafts and the practical professions

In the workshop the craftsman is taught, *inter alia*, to understand the sensory cues through which his movements are guided In his lessons in the classroom he is taught the more general principles upon which the versatility of his skill will depend Science has scarcely begun to explore the extremely complex problems that arise in connexion with the provision of general knowledge required in the exercise of a craft

Leadership and supervision may be taken as convenient examples of the social skills, the work of the manager or supervisor being quite peculiar Its essence is to know what requires to be done and then—not to do it—but to see to it that someone else does The kind of self-control that is required in order not to do oneself what should be delegated is one of the primary virtues in the supervisory office

On a systematic job-analysis of supervision or leadership, a primary and a secondary function can be distinguished The primary function is to direct, that is, to give direction to, and to co-ordinate, the activities of others This function is concerned with the job The secondary function is to arouse and maintain the motives appropriate to the actions of those who are so directed

Broadly speaking, the primary function is prominent at the higher levels of management or command, the secondary function more prominent at the lower levels The supervisor must know what has to be done, decide who shall do it, when, and sometimes how, the thing shall be done These decisions will find expression in the written or spoken word Hence the vital importance to his supervisory function of verbal intelligence and special verbal skills

Although much is not yet known, it is recognized that there is a common structure in the physical, the intellectual and the social skills In every case skill consists in the ability to produce required effects by executive action guided by relevant information In the rest of his article Prof Mace indicates the conditions through which all potential skills issue in performance T H HAWKINS

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Spectroscopic Evidence of the Participation of the Cytochrome - Cytochrome Oxidase System in the Active Transport of Salts

WITH a recording microspectrophotometer of special construction, the absorption spectrum of a bundle of twenty to forty roots of wheat shows distinct bands of cytochrome *c* (Fig 1) The bands of the cytochromes *b* and $a + a_3$ are also recognized as elevations of the curve The spectrum is calculated as the relation between the transparency of the roots in distilled water and the transparency after shifting over the medium to 0 001 *M* hydrogen cyanide, the cytochromes being partly in the oxidized state in the untreated roots The reduction in hydrogen cyanide is due to the blocking of the cytochrome oxidase at still operating dehydrogenases With carbon monoxide a broadening of the γ-band of cytochrome *b* is observed Calculated from the absorption at λ 550 mμ, the roots contain approximately 4 mgm cytochrome *c* per kgm fresh weight The cytochrome system is present at all lengths of the roots of two–three weeks old seedlings Also single roots of maize show similar spectra

The observations corroborate my earlier results as to anion respiration The continuous registration of the absorption spectrum of the roots enables the direct observation of the participation of the cytochrome system in the anion respiration. If the medium is changed from distilled water to a solution of 0 01 *M* potassium chloride, the γ-bands of the reduced cytochromes are rapidly changed The relation between oxidized and reduced cytochrome runs approximately parallel with the earlier established time course of the active absorption of chloride anions and the corresponding increase of the oxygen consumption

The new observations are in close agreement with the idea of a causal relation between the transport of electrons through the enzyme system, and the transport, in the opposite direction, of free-moving anions.

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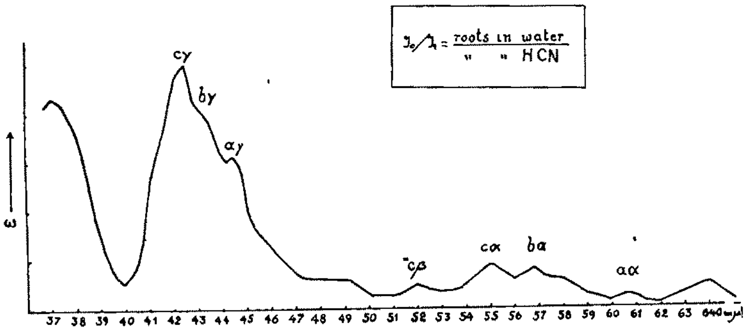

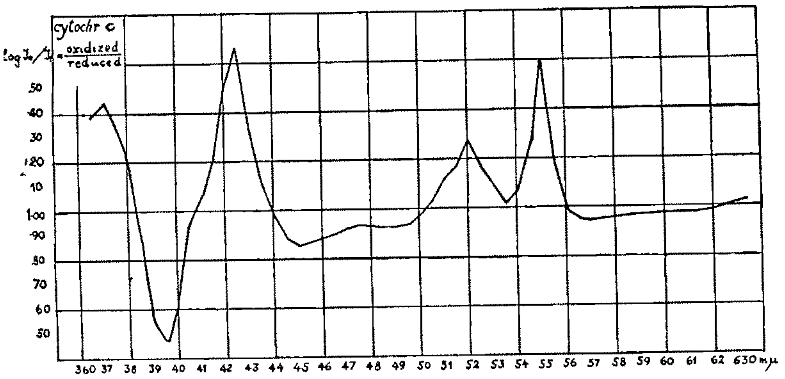

Fig 1 Absorption spectrum of a bundle of twenty-five wheat roots, calculated as the relation between the light absorption of roots in water and that of roots in 0 001 *M* hydrogen cyanide

Fig 2 Absorption spectrum of pure cytochrome *c*, calculated as the relation between the oxidized and reduced states (for comparison with Fig 1)

Relative Effects of the *n*-Butyl Esters of 2-Methyl 4-Chlorophenoxyacetic Acid and of 2 : 4-Dichlorophenoxyacetic Acid on Cereals

PREVIOUS experiments at Jealott's Hill[1] showed that the sodium salts of 2-methyl 4-chlorophenoxyacetic acid ('Methoxone') and 2 4-dichlorophenoxyacetic acid (DCPA) were similar in their effects on cereal crops on which they were dusted or sprayed in heavy doses, although only the latter produced marked malformations Synerholm and Zimmerman had earlier pointed out[2] for other plants the greater activity of 2 4-dichlorophenoxyacetic acid compared with 2-methyl 4-chlorophenoxyacetic acid in inducing formative effects When, instead of the sodium salts, oil-soluble esters of the two acids are compared on weed-free cereals, the differences as reflected in the grain yields become very marked, as shown, for example, in the accompanying table

The esters were each formulated in white oil, *cyclo*hexanol and 'Lissapol N' which, when diluted with water, gave emulsions which were sprayed at the equivalent of 100 gallons per acre The two compounds were compared on the basis of equal weights of acid per acre

On wheat and oats there was a greater degree of initial scorch from the 2 4-dichlorophenoxyacetic ester, but this quickly disappeared , malformed ears of wheat and barley also occurred only on these plots

In general agricultural practice, the esters in the available formulations have proved more potent than the corresponding sodium salts in aqueous solutions The apparent greater safety margin existing with the ester of 2-methyl 4-chlorophenoxyacetic acid as compared with that of 2 4 dichlorophenoxyacetic acid in the above trials suggested that it might be used in cereal crops against weeds having some resistance to the sodium salts Against field poppy

MEAN YIELDS OF GRAIN (CWT./ACRE)

Treatment	Applic.	Spring oats (var. Star) Applic. rate (lb./acre acid) 0	1	2	4	Spring barley (var. Abed Kenia) Applic. rate (lb./acre acid) 0	1	2	4
n-Butyl ester of 'Methoxone'	Early Late	26.1	24.2 25.0	24.8 23.9	21.8 20.5	30.7	29.0 31.4	26.1 31.1	22.4 20.9
n-Butyl ester of 2,4-D	Early Late		19.6 19.1	18.5 9.2	14.2 9.6		27.8 21.3	22.0 12.8	13.5 7.9
S.E. (single sub-plot)		±1.9				±2.1			
Coeff. of variation		8.1 per cent				8.4 per cent			
Sig. diff. control against other treatments		1.9				2.4			
Sig. diff. between treatments		2.5				3.0			

Early application	April 28, 1949 Oats 4 in. high	May 9, 1949 Barley 6 in. high
Late application	May 23, 1949 Oats 8 in. high	June 8, 1949 Barley 15 in. high

(*Papaver rhœas*), scentless mayweed (*Matricaria inodora*), amphibious bistort (*Polygonum amphibium*), knotgrass (*Polygonum aviculare*) and black bindweed (*Polygonum convolvulus*), the *n*-butyl ester of 2-methyl 4-chlorophenoxyacetic acid formulated as described above proved more effective than an aqueous solution of the sodium salt.

To what extent this difference is due to the ester itself rather than to the other constituents of the emulsion is not yet determined. The results given above, however, clearly indicate that it may be possible to use heavier doses of 2-methyl 4-chlorophenoxyacetic ester formulations on cereal crops than have so far been feasible with the widely used esters of 2 : 4-dichlorophenoxyacetic acid.

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A Rapid Method of Leaf Area Determination

RECENT physiological studies on nutrition and growth have shown that leaf area is a reliable index of growth factors determining dry matter accumulation, carbohydrate metabolism, yield and quality of crops[1-9, 12]. Various methods have therefore been devised for measuring the total leaf surface on a growing plant. Of these, mention may particularly be made of (1) methods based on tracing individual leaves and determining their respective area by planimeter, (2) use of sensitized photopapers, (3) photo-electric devices of various types, (4) adoption of cardboards of known area approximating to the area of different type leaves, and lastly (5) use of mathematical formulæ based on certain leaf measurements. The utility of one or the other of these methods has been stressed by different investigators.

Recently, we developed a simple method of estimating leaf surface in gramminaceous plants based on linear measurements of individual leaves. On the basis of such length and width measurements, it was possible to determine the leaf area (one surface only) by the formula

$$\log A = \log L + \log B - \log K, \qquad (1)$$

where L is length of leaf, B width of leaf in the middle of foliage, K average leaf factor $\left(\frac{L \times B}{\text{area}}\right)$ calculated previously for a population of leaves.

Use of this formula in barley[10,11], maize[11,12], paddy, sugar-cane and wheat gave an experimental error of 2.3, 1.9, 0.86, 0.67 and 0.048 per cent respectively when the measurements were extended to a population of twenty-two leaves.

The above formula may also be modified as

$$\log \Sigma A = \log \Sigma L + \log \Sigma B - \log K - \log N, \qquad (2)$$

if only the total leaf area exposed on the entire plant is desired. In this case all other factors remain the same except N, which indicates the total number of leaves sampled. The experimental error involved in the use of this formula has been found to vary as follows: barley 2.9, maize 6.6, paddy 3.3, sugar-cane 0.13 and wheat 1.0 per cent.

It would therefore appear that the above formula is well suited for biological investigations on growing plants where area is to be determined at successive stages of life-cycle. Its utility in gramminaceous plants is established. How far the application of a similar principle to other crops would be helpful is a matter for future investigation.

The method is simple and mechanical. It does not involve separation of leaves. No costly appliances are needed. The entire determination is completed within a short time. It is considered, therefore, to be an important means for determining area in growing gramminaceous plants.

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Occurrence of *Myxine* off the Berwickshire Coast

THE cyclostome *Myxine glutinosa* Linnæus is generally regarded nowadays as being fairly uncommon off the British coasts, though Meek, in 1916, stated that it was fairly common off the east coast of Scotland. Cole[1] found the species during 1905–25 in large numbers off Cullercoats, Northumberland, but of recent years there have been few records from that area.

For several years, and at all seasons, fishermen ive brought me odd specimens which have been ken from an area about five miles north-west of Abb's Head, Berwickshire The species is sufficiently common on these grounds to make the local shermen reluctant to set lines there, as the 'mack ls' interfere with the bait

During Easter 1949 an attempt was made to trap *yxine* in the area referred to above Ordinary crab ots, fitted with a fine-mesh net, and with a small erture for entry, were used, baited with fish Some gfish were taken, but the work had to be abanoned owing to bad weather In the summer of 1949 apping was resumed, and as many as nine specimens ere taken in a single trap It was found, however, at the traps were insufficiently strong to withstand e strong tides in the area, and it is hoped to try it a new type, consisting of a wooden box with a w small apertures

In August 1950, with the co-operation of Dr C E icas, of the Scottish Home Department Marine aboratory, an echometer survey, together with line undings using tallow, was carried out over the area esults showed that the *Myxine* ground was a mud ottom lying between two ridges in 35–40 fathoms water

It is hoped to conduct further experiments to tablish the extent of the colony and to record ssible migrations

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Interaction of Genes affecting the Wings in D. melanogaster

THE interaction among genes controlling the evelopment of the same organ has been studied in *rosophila* by Mainx[1] for some eye colours, by aletky[2] and by Trapani[3] for the wings, by Semenza[4] r the shape of the eye, and in *Habrobracon* by ark[5] for some factors affecting the wing-length

In the present investigation, I have brought gether in the same genome distinct mutant genes ntrolling the same organ, in the homozygotic, and, r the X-chromosome, in the hemizygotic state, spectively, so that each gene was able to manifest self during development In this way, it is possible detect if the phenogenetic actions of two genes mbined in the same genome and affecting the same aracter are of such nature as to sum their effects to exclude one another

The genes I used are the following N = Notch hromosome 1)[6], fa^n = facet notched (chromosome , sd^L = Leoni's scalloped (chromosome 1)[7], vg = stigial (chromosome 2) and blt^S = Semenza's blot hromosome 2) The latter, which arose sponneously in the laboratory from a Notch strain, oduces a reduction of the wing-size, generally companied by an accumulation of hæmolymph, so at the wing assumes the appearance of a sausage, lancers also are smaller, penetrance is complete and ability good Localization proved that this mutant an allele of *blt*

I obtained and examined the following combinaons $N - blt^S$ no interaction, since no individuals pear with both characters $fa^n - blt^S$ the pearance of the wings indicates a summing of both the genes in question, the wings are inflated, shorter than in blt^S and show at the distal extremity the nicks and the hair clumps peculiar to fa^n, veins are much enlarged, more than in fa^n, and often a little deformed, balancers are reduced, the effects in males and females are the same $sd^L - blt^S$ no interaction, since no individuals appear with both characters $vg - blt^S$ wings, very reduced in size, appear as two small balloons, veins are often lacking, balancers are wrinkled or lacking

These results show that fa^n and vg are quite recognizable in the individual which contains, at the same time, the blt^S gene, but they also show an increase in intensity, while N and sd^L block the accumulation of hæmolymph peculiar to blt^S, so that in the combination the latter does not appear Another possible explanation is that the combinations $sd^L - blt^S$ and $N - blt^S$ are not viable

I conclude, therefore, that *vestigial*, *blot*^{S} and *facet notched* seem to be more analogous in their action than *blot*^{S}, *Notch* and *scalloped*^{L}

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Microclimate Close to the Ground

RECENT communications[1,2] have directed attention to the importance to the biologist of the peculiar microclimate on the ground and among ground vegetation A thin hot layer of air covers the surface of bare earth in sunshine, and among vegetation it is lifted to a height which depends upon the height and density of the vegetation Measurement of the temperature of this air is difficult the temperature-profile is steep and is likely to be disturbed by the ventilation of an aspiration thermometer When using an aspiration thermocouple over bare earth, I have found that the galvanometer reading rises initially to a high value and then falls, suggesting that hot air is being withdrawn and replaced by colder

There is another approach to this problem The biologist is primarily interested in the temperature of bodies—animals and plants—which will not as a rule be the same as air temperature Most of the factors responsible for the temperature of small 'cold-blooded' animals are also responsible for the temperature of inanimate bodies in similar situations, and a study of the latter may be expected to throw some light upon what governs the former and at the same time offer certain experimental amenities The accompanying table shows the equilibrium temperature of a black metal disk $\frac{3}{4}$ in diam and $\frac{1}{8}$ in thick suspended horizontally in full sunshine at different heights above (*a*) a smooth table, (*b*) a 1-in clearing plucked in a lawn about 1 in high, (*c*) a metal sheet 2 ft square covered with a 'vegetation' of drinking straws 2 in high spaced at random about $\frac{1}{2}$ in apart The temperature of the metal sheet (c) could be both measured and varied, and results were obtained (i) when it was allowed to reach its full temperature, and (ii) when it was cooled by means of the water coil

Height above ground	Smooth table (*a*)	1-in lawn (*b*)	Artificial vegetation 2 in high (*c*)	
			'Ground' 52° C	'Ground' 35° C
Just clear	Δt = 10° C	Δt = 15° C	Δt = 22° C	Δt = 6° C
⅛ in	—	15	20	8
¼ ,,	—	11	19	7
½ ,,	1	7	18	11
1 ,,	0	3	16	10
1½ ,,	—	—	10	10
2 ,,	—	—	8	6
3 ft	t = 37 ± 1 7° C	t = 39 ± 1 5° C	t = 33 ± 1 9° C	t = 34 ± 1 4° C
Shade temp	t = 26° C	t = 26° C	t = 21° C	t = 21° C

beneath The temperatures were measured by a small thermistor element inside the body connected by platinum wire 0 002 in in diameter, and are expressed as differences from those of an exactly similar body exposed in free air 3 ft above the ground nearby The mean actual temperature of this reference body is given, together with the shade temperature of an ordinary thermometer 4 ft from the ground

These results indicate (1) the high temperatures reached by a body of this size when close to the ground, compared with its temperature in free air , (2) the very shallow boundary layer, within which these temperatures prevail, over a smooth surface , (3) the effect of roughness in deepening this boundary layer , (4) the much greater importance of high ground temperature compared with the lowering of air velocity in producing these high body temperatures close to the ground.

Recent bad weather has prevented more than one comparison between the metal body and a living arthropod (*Locusta migratoria migratorioides*, dark phase rectal temperature), when the following differences in temperature were found Δt = + 0 9, + 0 8, + 3 3° C (height, 9 in above table, locust broadside to sun , + indicates body hotter than locust) On general grounds it is suspected that the various physical factors (which determine the temperature of an inanimate object) play a greater part than the biological ones in the temperature of small 'cold-blooded' animals the heat-production of which is small and which cannot afford much water loss Of these physical factors, reflectivity, shape and size remain to be considered, and it is probable that absolute size is of great importance, not because of the operation of the two-thirds power law encountered among warm-blooded animals, but because of the dependence of convection transfer coefficients upon the absolute size of the surface considered

This work will be published in detail elsewhere

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DDT as a Residual Insecticide against *A. letifer* and *A. maculatus* in Malaya

MUIRHEAD THOMSON[1] has recorded the observations that DDT is not effective in the control of *A gambiæ* due to its irritant effect on fed anophelines, which prevented them from resting long enough on treated surfaces to absorb a lethal dose Various other workers have since published their findings, which indicat that this insecticide has either residual[2 3], repellent[4– irritant[3 7] or fumigant[6] effect on different species c mosquitoes During experiments in a hyperendemi malarious village (*A letifer* area) in Malaya, I sprayed the entire interior and exterior walls of all habitation three times within four months with a 5 per cen DDT solution in kerosene at the rate of 100 mgm pe sq ft After every treatment, the mosquito collectio from the catching stations from 6 a m to 6 p m wa observed to be practically nil for two to four week after which a few mosquitoes started to appear.

The complete absence of mosquitoes during night in the sprayed houses suggested the study of th behaviour of the local mosquitoes to DDT spray and accordingly the following preliminary experimen was carried out

After shifting the occupants of one block of house in the experimental village to an adjoining one, a the vacated houses were sprayed with DDT, treatin both outside and inside walls with the same dosag and formulation of DDT as in the main experimen Immediately after spraying, the floors of these house were covered with white hospital sheets, taking car to fit them properly against the walls As human bai two persons slept during nights in each of the treate houses for a period of fourteen days from the da of spraying Dead insects fallen on the whit sheets were picked up both in the morning and even ing during these fourteen days and examined Th daily collection consisted of numerous dead blac ants, a few cockroaches, some spiders, very fe beetles and glow-worms, but no mosquitoes Th number of these dead insects, however, graduall declined and on the fourteenth day it was only abou a fourth of the collection of the first day

The repellent effect of kerosene used in the pr paration of DDT solution cannot definitely be factor for the absence of dead mosquitoes in th daily collection, as it has been shown that the effe of kerosene lasts only for a maximum period of a ha to five days (ref 1 last paper, and ref 9) It therefore likely that the mosquitoes settled on th outside walls for sufficiently long to get a lethal c sub-lethal dose and ultimately flew away withou entering the building It may be mentioned in th connexion that, in a similar group of houses in a *A maculatus* area, only the outside walls were spraye during the course of these experiments, and in th particular case 16 per cent of the pre-spray catc of mosquitoes comprising both anophelines an culicines were collected during the first post-spra collection on the third day and 30 per cent on th eighth day after treatment. Therefore, the absence dead mosquitoes in the first group of sprayed hous during a minimum period of not less than fourtee days appears to be due to the effect of spraying bot outside and inside walls The probability that mo quitoes might have entered houses but escaped imm diately after feeding without touching any of th treated surfaces is very remote, as it is highly unlikel that all types of mosquitoes, anophelines and culicine behaved in this orderly and disciplined manner It admitted that the finding in this experiment is n sufficient to come to a definite conclusion on th mode of action of DDT against local mosquitoes but the probability appears to be that mosquito after entry were irritated on coming in contact wit the DDT-treated surface and escaped

The entomological findings recorded after the initi mosquito 'vacuum' in the treated villages in th main experiment (*loc cit*) showed that the number of anophelines caught was far less than the collection in the control village (average anopheline catch per night 2 7 as against 25 in the nearest comparison station) The average number of engorged anophelines caught per night from the sprayed area was 0 32, while the same in the comparison station was 12 Mortality occurred of 22 per cent of the total collection in this experiment within 4–12 hr from the time of capture, and in another 33 per cent within 12–16 hr The reduction of mosquitoes obtained in the house catches was not, however, associated with a reduction of larval density in the area treated

The spleen-rate in the treated villages was reduced from 63 5 to 39 5 per cent without any decline in the control village The parasite-rate remained relatively unchanged in the experimental village, and increased markedly in the control village There was an increase, however, of *P falciparum* infection in the treated village

These findings indicate that whatever be the nature of action of DDT against *A letifer*, it can control malaria in the areas where this species is the vector It also shows that this effect is short-lived when compared to the findings in most other countries, probably due mainly to the outdoor resting and, on occasions, outdoor feeding habits of *A letifer* Another vector in Malaya, even more important than *A letifer*, is *A maculatus* Logically speaking, better results are to be obtained with this species than with *A letifer* because, although *A maculatus* is also an outdoor rester, it is not at least recorded as an outdoor feeder Opinion regarding the utility of DDT against this vector is, however, not unanimous While Wallace[10] believes that this insecticide is ineffective, the findings of Warton and Reed[3] do not confirm this Further investigations are therefore necessary to throw more light on the effect and mode of action of DDT against the vectors in Malaya

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Number of Radiolaria in Sediments

Through the courtesy of Dr B Kullenberg, who is in charge of the study of the sediment cores from the Indian Ocean taken by him with the aid of his revolutionary sampler during the Swedish Deep-Sea Expedition, I have been able to examine several of the cores from that Ocean for microfossils These investigations have been mainly restricted to the Radiolaria, and on this subject there is considerable disparity between our results and those of the *John Murray* Expedition to the same area As this lack of agreement involves the matter of the technique of investigation of the biological components of deep-sea sediments, it is considered advisable to publish a short notice before the appearance of the complete reports of the Expedition

As has been the practice in dealing with most deep-sea sediments obtained by recent expeditions, the biological contributions to the sediments collected by the *John Murray* Expedition were determined after the coarse particles had been separated from the 'mud' fraction by means of a sieve with meshes approximately 160 μ in diameter On examining the coarse material obtained in this way, Stubbings[1] reports that Radiolaria are often absent from the sediments, or occur but sparingly he says, "even in the South Somali Basin, in which Murray and Philippi (1908) record a large area of the bottom as covered with Radiolarian ooze, none were obtained"

Examination of the Swedish samples from the same general area have confirmed the presence of radiolarian ooze in the Somali Basin, and have shown that a great number of Radiolaria are present in the sediments of many parts of the western Indian Ocean The majority of these Radiolaria are of the order of 50–100 μ in diameter and would pass through the sieves usually used, moreover, a large proportion of them are of such delicacy that treatment of almost any kind would destroy them or render them unrecognizable For the present investigation, a small amount of the sediment was placed on a microscopic slide, the calcareous components were dissolved with dilute hydrochloric acid, and the Radiolaria counted directly The accompanying table gives the number of radiolarian skeletons per gram of air-dry sediment, from six localities between the Seychelles and Cape Guardafui

Core Station No	Position Lat	Position Long	Depth	No of Radiolaria (per gm)
152	S 03° 18′	E 56° 47′	4 065 m	300,000
153	S 02° 18′	E 55° 33′	4 360 m	500,000
154	S 00° 23′	E 54° 30′	4,860 m	450,000
155	N 04° 28′	E 52° 48′	5,117 m	300,000
156	N 07° 14′	E 52° 49′	5,107 m	350,000
157	N 08° 05′	E 53° 03′	5,100 m	1,000,000

From the large amount of material from the Pacific Ocean which Prof Hans Pettersson has generously placed at my disposal, it has been possible to compare the number of Radiolaria there with those of the Indian Ocean A sample from lat N 00° 20′, long W 150° 36′ (depth 4,405 m), in the region of the well-known Central Pacific radiolarian ooze, contains 540,000 Radiolaria per gram of air-dry sediment As an example of a shallower sediment containing a high proportion of comparatively coarse terrigenous material, a similar examination was carried out on green mud from the Gulf of Aden (N 11° 57′, E 44° 18′, depth only 883 m) here the occurrence of Radiolaria is of the order of 500 per gram of sediment

The results from this investigation, which will be published in greater detail in the Reports of the Swedish Deep-Sea Expedition, emphasize the importance of a thorough examination of the finer fractions of marine sediments, if this is not carried out, wrong conclusions will inevitably be drawn from reports of the absence or scarcity of some of the biogenic components

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Blood-Groups of Mental Defectives and their Maternal Parents

A study has recently been made of a random sample of 370 certified mentally defective persons living in East Anglia. Among other data, the *ABO* and the Rhesus blood-groups of each patient and of his or her mother were determined.

Of these 370 defectives, 118 could be placed in definite categories, either because their mental defect was part of a distinct physical syndrome, such as mongolism or cretinism, or because their history included some episode, such as cerebrospinal meningitis, which was the probable cause of their defect. The remaining 252 were 'undifferentiated', that is, their defect was not part of a recognizable syndrome or attributable to any known cause.

The *ABO* grouping of these 252 pairs of child and mother was as follows: *O*, 226 (44.8 per cent); *A*, 234 (46.4 per cent); *B*, 31 (6.0 per cent); *AB*, 13 (2.5 per cent). In 55 cases, mother and child were incompatible on the *ABO* system, that is, the mother's blood contained natural agglutinins which would *in vitro* have clumped her baby's erythrocytes. The 'secretor' character was tested in 42 of the children of these 55 pairs; 29 were secretors of group-specific substances, 13 non-secretors. These percentages approximate to those found by Race[1] in typing 1,571 East Anglian bloods for the Galton Laboratory. He found: *O*, 42.46 per cent; *A*, 46.40 per cent; *B*, 7.7 per cent; *AB*, 3.37 per cent. There appears to be a slight excess of *A* over *O* in East Anglia.

As regards the Rhesus system, however, the figures are more interesting. Of the 252 undifferentiated pairs, the bloods of 196 pairs were examined by means of six sera for the presence of the antigens *A*, *B*, *D*, *c*, *E* and *C*; the remaining bloods were tested, at the same times and with the same sera, for the presence of *A*, *B* and *D*. Of 252 children, 61 lack the antigen *D* and are homozygous *dd*. Of 252 mothers, 57 lack the antigen *D* and are homozygous *dd*. Pairs consisting of a *dd* mother and a *D* child occurred 31 times.

It is well known that a pregnant woman whose baby's blood contains a group-specific substance lacking in her own blood may be stimulated by that foreign substance to produce abnormal antibodies against her own child. The injuries caused to the unborn child by these maternal antibodies result in all the manifestations of hæmolytic disease of the new-born. One such result is kernicterus, in which a severe hæmolytic jaundice is followed by spasticity, athetosis, and mental retardation. Post-mortems on cases dying within a few days after birth show many of the cerebral ganglia stained, and containing many degenerated neurones, possibly as the result of the toxic products of hæmolysis, or possibly as the result of an antigen–antibody reaction occurring in the ganglia.

This new knowledge that mental deficiency sometimes occurred in a child severely injured by antibodies aroused several workers to inquire whether immunization of the mother might explain some hitherto inexplicable cases of undifferentiated mental defect[2-7]. The figures given above, on a random sample culled from all grades of defectives, give no support to this idea.

The serum of each of the 24 *dd* mothers whose defective *D* child had been born within the past sixteen years was examined for antibodies. Abnormal antibodies were found in the serum of one mother; but her defective child was her first pregnancy, and a microcephalic; she had not been previously transfused, and her second child was healthy and normal. The defect in the first child cannot be attributed to the effect of antibodies.

But the number of *dd* children in the sample is unexpectedly high. If we take 16.8 as the percentage of *dd* persons to be found in the general population in England[8], we get the following figures:

Children	*D*	*dd*
Observed	191	61
Expected	209.7	42.3

χ^2 for one degree of freedom is 9.94; that is, the chance that the proportion of *dd* children is an accident of sampling is about 1 in 1,000.

The mothers are selected, since they came into the survey because they were the mothers of these particular defectives. In a population containing 16.8 per cent of *dd* individuals, the mothers of 191 *D* children and 61 *dd* children would be expected to comprise 204.2 *D*'s and 47.8 *dd*'s. Comparison with the observed numbers shows:

Mothers	*D*	*dd*
Observed	195	57
Expected	204.2	47.8

χ^2 for one degree of freedom is 2.18.

There is some excess of *dd* mothers; but this is non-significant and, whatever larger numbers might reveal, the only peculiarity of this body of data is the unexplained excess of *dd* subjects among the undifferentiated defectives.

The sera used in these tests were individual immune sera of high titre supplied by the kindness of Dr. A. E. Mourant of the Blood Group Reference Laboratory, Lister Institute. The same sera were used throughout and retained their absolute specificity and high titre to the end.

Part of this work, of which a full account will be published elsewhere, was done during tenure of the Gwynaeth Pretty Studentship, University of Cambridge.

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Macular Pigment

Macular pigment, usually found in post-mortem eyes, is also said by Keilin and Smith[1] and by Wald[2] to be present in the living human eye, and either to be lutein itself or a closely related chemical substance. Others, however, for example, Gullstrand[3] and Wolff[4], hold a different view. They believe this pigment to be present in the macula only after death, but not in the normal eye in health. I believe the latter view to be correct, because I have found evidence, thought to be in favour of the presence of this pigment in the living state, to be misleading , namely, the dark bands seen at the short wave-length end of the spectrum by Maxwell[6] and by Keilin and Smith[1], and the relative blue blindness of the macular area compared with the perimacular region around it, found by Tscherning[6], by Willmer[7] and by others Both these phenomena have been ascribed to macular pigmentation

A colour filter was prepared which produced a single absorption band in the visible spectrum from about 0 515 µ to about 0 540 µ When this band was examined through spectroscopes of different dispersion, it was found to be visible in them all When spectra of different light intensities were examined, it was found that the absorption band was always visible, although differences in apparent width were, of course, noticeable Lastly, alterations in the top-to-bottom dimensions of the spectra were found to be without apparent effect on the appearance of the absorption band Similar tests performed with other colour filters lead to similar conclusions, namely, that the absorption bands are constantly present in spite of alterations in dispersion, in light intensity and in top-to-bottom dimensions of the spectra in which they are seen

The absorption bands supposed to be caused by macular pigment were now tested in a similar manner It was found that the bands were present when the dispersion of the spectrum was small but not when it was large, that the bands were present at medium light intensities but not at high ones, and that the bands were more readily observed when the spectrum was narrow than when it was wide Thus in these three respects the behaviour of the bands differs from those produced by pigments On these grounds it seems unlikely that the bands are caused by pigments

If the macula is relatively blue blind owing to the local presence of pigment, it would be expected that this blindness would be found at all light intensities Such is not the case, however, because as the light intensity is increased the macular area becomes progressively more sensitive to blue and violet rays, with the result that first it draws level with the perimacular region in blue sensitivity, and then with a further increase in light intensity actually exceeds the latter This change-over can be witnessed by looking through a colour filter which transmits red rays and blue rays, but absorbs the orange, the yellow, the green and the blue-green At a light intensity of one foot-candle, the macula has 0 4 times the blue sensitivity of the perimacula At a light intensity of fifty foot-candles, the two retinal regions are about equal in blue sensitivity At a light intensity of one thousand foot-candles, the macula is roughly ten times as blue-sensitive as the perimacula

These effects might be explained on the basis that the macular pigment becomes bleached as light intensity is increased, and thus discloses when it has done so the normal high sensitivity of the macula to blue light But against the acceptance of this explanation is the fact that, on returning quickly to a low light intensity, the relative blue deficiency of the macula at once discloses itself We see then that none of these effects can be adequately accounted for on the basis of pigmentation To what, then, are they due ?

It was found by me that there are two parts of the spectrum which have anomalous properties , one of these is in the yellow and the other in the blue Adequate illumination and a sufficiently large visual angle are both requisite in order that yellow and blue shall be recognized If these conditions are not fulfilled, both these colours are replaced by neutral grey a pale grey in the case of yellow, but a dark grey in the case of blue This loss of colour on the part of both yellow and blue was found to take place at the fovea, and at other parts of the retina as well, but in most subjects, at ordinary light intensities, somewhat more readily at the fovea

Let us now examine the hypothesis that normal blue perception is dependent on the operation of specific blue receptors, and that when these cease to operate in a normal manner two phenomena show themselves (*a*) the appearance of a dark band or bands in the blue part of the spectrum, and (*b*) the occurrence of defective blue vision If this hypothesis is correct, there should be a band or bands in the blue part of the spectrum when light intensity is low but not when it is high—visible bands when the spectrum is short or narrow, but not when it is long or wide There should be relative blue blindness at the macula when light intensity is low, but not when it is high In all these respects there is agreement with experiment, and it is therefore concluded that the hypothesis is correct

Let us now take up the point made by Keilin and Smith and confirmed by Wald and by Thomson, namely, that the bands in the blue closely resemble, if they are not identical with, those of the plant pigment lutein There seems to be one way, and one way only, of explaining the resemblance, namely, that lutein present in the human retina acts as the photocatalyst for the blue receptors, just as rhodopsin does for the red receptors If this explanation is correct, we may usefully recall the following facts that vitamin A is known to play an essential part in human vision, and that both visual purple and lutein are vitamin A derivatives Returning to the matter of the macular pigment which develops in post-mortem eyes, it seems likely that this is derived either from vitamin A or from the visual pigments which are themselves vitamin A derivatives, or from both these sources

Two further references should be made (*a*) to the paper of Prof Nordenson[8] on the intravital colour of the macula, in which he writes, "there is a great deal of evidence in favour of the opinion that there is no yellow colour in the macula of the live eye", and (*b*) to the letters in *Nature* a year ago by Dartnall and Thomson[9], by Denton and Pirenne[10], by Tansley[11], and by Hartridge[12]

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Sept 19

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Low-Angle X-Ray Scattering from Ramie and Jute

A SHORT well-defined streak at right angles to the direction of the fibre axis is seen on both sides of the lead beam-trap on X-ray photographs of natural cellulosic fibres taken under suitable conditions Kratky[1] and Kratky and Porod[2] consider that this low-angle X-ray scattering can be attributed to the close-packing of crystallites, and this hypothesis is corroborated by work of Heyn[3,4] In the course of a study of the structure of jute and other fibres, I have repeated some of Heyn's experiments, and have also examined the effect produced by removal of lignin upon the intermicellar swelling of jute fibre in water

Measurements of the low-angle scattering from flax, hemp and jute agreed very closely with results reported by Heyn, but abnormal behaviour of ramie was not confirmed Heyn obtained identical X-ray photographs from native ramie and ramie swollen in sodium hydroxide solution, and reported[6] the smallest intermicellar period, calculated from the total length of the streak, as 34 A (assuming the validity of Bragg's law for the low-angle scattering) Low-angle X-ray photographs of native ramie dry and swollen in water which I have obtained (Figs 1 and 2) show that the entry of water into the intermicellar spaces in ramie produces (*a*) a considerable increase of the intensity of the scattering owing to the difference of scattering powers of water and cellulose, and (*b*) a decrease of the total length of the streak owing to the increase of the intermicellar distances The smallest intermicellar periods for native ramie calculated from Figs 1 and 2 are 24 A for the dry fibre and 27 A for the fibre swollen in water

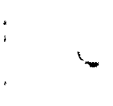
Fig 1
Dry ramie

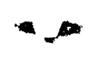
Fig 2
Ramie swollen in water

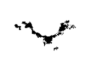
Fig 3
Dry raw jute

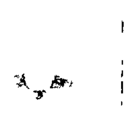
Fig 4
Raw jute swollen in water

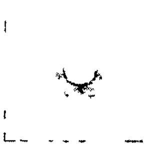
Fig 5
Dry delignified jute

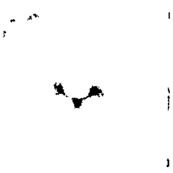
Fig 6
Delignified jute swollen in water

Heyn has observed[6] that the characteristic streak obtained from wet jute fibre is more intense but only very slightly shorter than the streak obtained from the same fibre when dry Figs 3 and 4, which show the low-angle X-ray scattering from raw jute dry and jute swollen in water, are similar to the photographs published by Heyn[4] and are reproduced here for purposes of comparison

It seems reasonable to suppose that the presence of lignin in jute is responsible for the fact that the change in the low-angle scattering caused by the swelling of jute in water is considerably smaller than an analogous change caused by the swelling of ramie, and in order to test this assumption a sample of delignified jute was examined. The low-angle X-ray scattering from dry delignified jute (Fig 5) differs little from that obtained with normal jute fibre, but the change in the low-angle pattern subsequent to swelling of delignified jute in water (Fig 6) is considerable, and is comparable with a similar change observed in the case of ramie It is thus evident that the lignin in jute hinders intermicellar swelling in water

The intensity of the low-angle scattering from dry fibres of jute and ramie and also from wet, but otherwise untreated, jute is nearly uniform along the whole length of the streak and falls off very rapidly at the ends In the cases of swollen fibres of ramie and delignified jute, a strong intensity maximum is observed at the centre of the streak

This work was part of an investigation undertaken on behalf of the British Jute Trade Research Association, by permission of which this communication is published The experimental work was carried out in the Department of Physics, University College, Dundee, by permission of Prof G D Preston

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Wave Equation of the Electron

FOR the description of an electron by a wave equation, the simplest equation available is the Dirac equation, which in the usual notation reads

$$[\gamma^\mu(i\partial_\mu + eA_\mu) - \varkappa]\psi = 0$$

This corresponds to a point particle of charge e, spin $\frac{1}{2}\hbar$ and magnetic moment $e\hbar/2mc$ This equation has met with marked success in describing an electron in static fields and slowly varying fields For high-frequency fields, however, there are indications that the description is only an approximate one, and that allowance should be made for the finite extension of the electron

In the classical theory of point particles there arises the difficulty that the equations of motion give rise to certain run-away solutions with non-physical characteristics If one uses a finite model instead of a point model, there is good hope that these difficulties would not arise[1]. There is at present no satisfactory means of describing a finite particle in quantum mechanics. In classical mechanics a finite particle is described by complicated integral equations In quantum mechanics the situation would be still more complicated, and one would expect that an infinite system of operators would be required for adequate description

An initial attempt on simpler lines may be made as follows. Consider an equation of the form

$$[\gamma^{\mu}(i\partial_{\mu}+eA_{\mu}) - \varkappa + \{S^{\mu\nu}f_{\mu\nu} + \quad + S^{\mu_1\sigma} \quad \rho \frac{\partial^{n}f_{\mu\nu}}{\partial x^{\sigma} \quad \partial x^{\rho}} + \quad \}]\psi = 0,$$

where $f_{\mu\nu} = \partial_{\mu}A_{\nu} - \partial_{\nu}A_{\mu}$ give the field components, and the infinite series in curly brackets represents the additional contributions to the Hamiltonian from the multipole interactions of the particle with the electromagnetic field Such an equation would describe an electron which is a superposition of a point charge, a point dipole and point multipoles to all orders, and one might expect it to describe a finite electron The additional terms are negligible when the field $f_{\mu\nu}$ varies slowly, but will be important for fields of high frequency

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Polarographic Investigation of the Antigen–Antibody Reaction

USING azo-protein as antigen, preliminary experiments were carried out to investigate whether the polarographic method could be used for a quantitative determination of immunological reactions

Azo-protein was prepared by coupling egg albumin with diazotized *p*-aminobenzoic acid following the method of Landsteiner[1] For polarographic investigation the product from 1 gm of egg albumin was dissolved in 80 ml of acetate-phosphate-borate buffer[2], *p*H 7 3 Allowing for an 80 per cent reaction yield, this gives an approximately 1 per cent solution of azo-protein

A polarographic step was obtained between 240 and 440 mV vs the saturated calomel cell The step was not very well defined but could be determined (Table 1) and reproduced with reasonable accuracy (approximately ± 5 per cent) Within this limit of accuracy, the step height was proportional to concentration, as we have found in experiments using buffer as diluent (Table 2)

Further experiments showed that the azo-protein solutions used were stable for several weeks under laboratory conditions

Specific antiserum was prepared by giving rabbits a series of six injections at seven-day intervals Each injection consisted of 5 ml of approximately 1 per cent azo-protein solution The rabbits were bled two weeks after the final injection, the blood clotted and the serum separated by centrifugation Precipitation tests showed the serum to be active, and it gave best results by reaction with a 1 per cent solution of antigen with diluted antiserum (1 4), both in buffer.

TABLE 1

I_d measured (amp × 10^{-7})	I_d average (amp × 10^{-7})	Deviation (per cent)
3 06	3 03	+ 1 0
3 04		+ 0 3
2 99		− 1 3

TABLE 2

Dilution	I_d measured (amp × 10^{-7})	I_d mean value* (amp × 10^{-7})	Deviation from mean value (per cent)
0	3 74	3 87	− 3 4
1 1	2 17	2 12	+ 2 4
1 3	1 29	1 24	+ 4 0
1 7	0 78	0 80	− 2 5

* The mean value was obtained from a calibration curve plotting concentration against current

Experiments were then carried out to examine the effect of the addition of specific and unspecific sera upon the azo-protein polarographic step Unspecific serum merely acted as a normal diluent, whereas the addition of unspecific antiserum under the same conditions of concentration, etc, sharply decreased the step height

Table 3 shows the typical results obtained with two out of a considerable number of specific antisera examined

TABLE 3

Volume of unspecific serum added per ml of azo-protein	Volume of anti-serum No 1 added per ml of azo-protein	Volume of anti-serum No 2 added per ml of azo-protein	I_d measured (amp × 10^{-7})	I_d mean value (derived on the basis of dilution) (amp × 10^{-7})	Difference from mean value (per cent)
0	0	0	4 06	4 02	+ 1 0
1 ml			2 03	2 02	+ 0 5
	1 ml		1 52	2 02	−24 8
		1 ml	1 58	2 02	−21 8
2 ml			1 39	1 35	+ 3 0
	2 ml		0 90	1 35	−33 3
		2 ml	0 96	1 35	−28 9

From these results it is clear that the antigen–antibody reaction can be detected and measured by polarographic procedure Work is in progress to perfect the quantitative aspect of the method, with the object of applying polarography to the study of the kinetics of the antigen-antibody reaction

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Reversed-Phase Partition Chromatography

IN the course of experiments involving the use of powdered glass as a carrier in partition chromatography, we have found that it is possible to prepare columns having as the stationary phase either an aqueous liquid or a water-immiscible organic solvent Columns in which a stationary aqueous phase is distributed on glass have already been applied to the fractionation of the alkaloids of *Punica Granatum*[1] We now find that satisfactory reversed-phase columns may be prepared by the following procedure Chloroform (8 c c) is shaken thoroughly with 'Pyrex' glass (80 gm) in No 100 powder The 'wetted' glass is tipped into water (100 c c), previously saturated with chloroform, and the mixture is mechanically stirred at moderate speed with an upflow stirrer until all globules of chloroform are disintegrated, the slurry is poured into the chromatogram tube and again thoroughly shaken The column is allowed to pack spontaneously by draining in a vertical position, and the top is tamped by gentle pressure on a disk of filter-paper placed above the packed column Similar columns can be prepared using benzene instead of chloroform. Attempts to prepare this type of column employing kieselguhr as carrier were unsuccessful.

With chloroform as the stationary phase and water saturated with chloroform as the mobile phase, almost quantitative recoveries of the components of mixtures of *o*-nitraniline (9–12 mgm.) and *p*-nitraniline (9–12 mgm.) and of *o*-nitrophenol (9–20 mgm.) and *p*-nitrophenol (12–50 mgm.) were obtained. A mixture of hyoscine (14 mgm.) and hyoscyamine (9 mgm.) was only partially fractionated under similar conditions, but when the mobile aqueous phase was adjusted to about *p*H 9 by the addition of sodium hydroxide and saturated with chloroform, pure hyoscine was recovered.

Although it is probable that this type of partition chromatographic column is metastable, no displacement of the organic solvent, tinted with Sudan III, was apparent when up to 2,000 c.c. of aqueous phase was passed through. There was no evidence of breakdown of these columns up to 72 hr. after preparation, and in one experiment a column used for the separation of *o*- and *p*-nitranilines was again used, without further treatment, for the separation of *o*- and *p*-nitrophenols.

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Recovery of Radioactive Iodine from Urine

Owing to the high cost of radioactive iodine, the therapeutic use of this isotope in the treatment of certain cases of malignant disease of the thyroid gland is accompanied by the problem of recovery of the isotope from urine for re-administration. Originally in this Hospital we have used a rather complicated recovery process based upon a method kindly furnished by Baumann (private communication), which is similar to that used in the micro-estimation of iodine[1]. In brief, this process was as follows.

The patient receives the dose of iodine-131 (150–200 mC.) together with a capsule containing 100 mgm. of methylene blue which serves to identify the high-activity urine by its blue colour. The urine is collected for 24 hr., acidified with dilute sulphuric acid (to prevent frothing) and concentrated *in vacuo* to about 200–300 ml. This is divided into two or three fractions which are worked up separately. Organic matter and chloride are eliminated by treatment with chromic and sulphuric acids and heating up to 180° C. Chromic acid has to be present in excess throughout to maintain the iodine as iodate, otherwise it is lost as hydriodic acid. Following this, the excess chromic acid is reduced with oxalic acid and the iodine distilled as hydrogen iodide into dilute alkali. The entire procedure occupies about two to three days, with two operators required for the oxidation and distillation processes. In addition, the reaction is apt to be unpredictable, violent, and difficult to control. Yields of 60–70 per cent of the initial urinary activity can be obtained.

We have now devised a simple process for the recovery of radioactive iodine which requires little supervision and is almost devoid of risk. Investigation of the conditions under which iodine-131 is carried down as iodide during the precipitation of chloride by silver nitrate has furnished results shown in Table 1. More than 95 per cent of the iodine-131, whether free from carrier or in the presence of appreciable quantities of iodide, is brought down when only 15 per cent of the total chloride is precipitated. The percentage precipitation of the iodide is not markedly affected by variations in hydrogen-ion concentration.

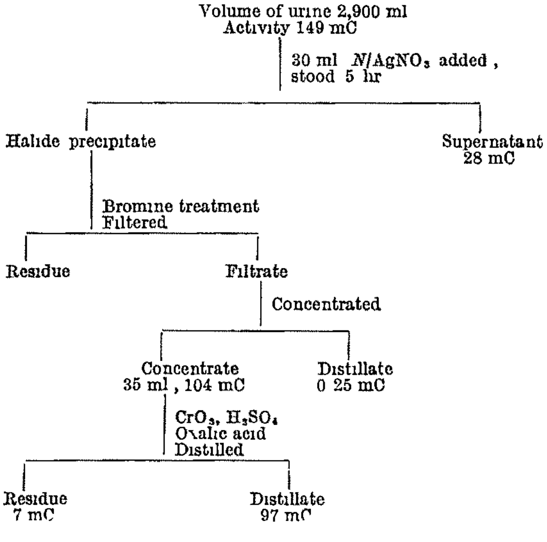
Table 1

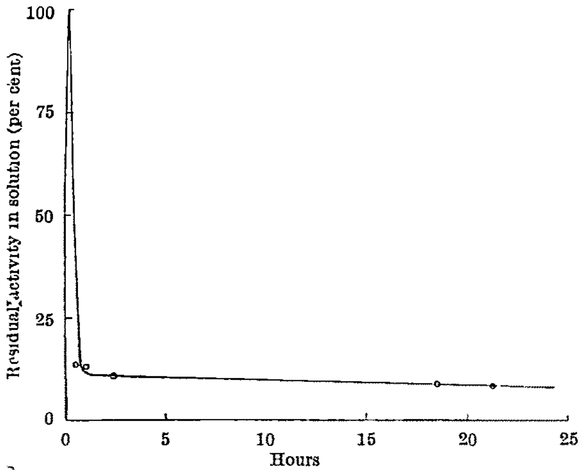
Percentage chloride precipitated	Carrier iodide present		Carrier-free iodide	
	Initial activity (counts/min.)	Percentage activity unprecipitated	Initial activity (counts/min.)	Percentage activity unprecipitated
0	196,000	100	237,000	100
1.3	27,000	13.7	10,250	4.3
2.6	10,400	5.3	8,400	3.5
4.5	8,300	4.2	9,800	4.1
6.5	6,100	3.1	8,300	3.5
11.7	7,000	3.6	4,900	2.1
16.2	4,200	2.1	4,600	1.9
20.8	3,600	1.8	3,200	1.3
41.0	750	0.4	2,700	1.1
81.2	250	0.1	2,500	1.1

Application of this method to urine containing radioactive iodine, followed by collection of the precipitated halide and attempts to distil off the iodide directly, using concentrated sulphuric acid, were unsuccessful. However, treatment of the silver halide with an excess of bromine almost completely removes the iodide and oxidizes it to iodate. The procedure adopted for the recovery of radioactive iodine from a patient's urine after a therapeutic dose is as follows.

A solution of normal silver nitrate equivalent to 15 per cent of the total urinary chloride is added with stirring to the urine contained in a 3-litre gas-jar. The precipitate is allowed to settle until the supernatant fluid shows the requisite fall in activity (fo example, 5 hr., or overnight) after which it is syphoned off as completely as possible and the residue treated with an excess of bromine (10 gm.) with stirring. The mixture is left standing for two o three hours, or overnight if more convenient, filtered through a fluted filter and the residue washed with bromine water. The filtrate and washings contain most of the radioactive iodine as iodate and are nex transferred to a round-bottomed flask (1 litre) having a standard joint neck. The bromine is boiled of

Table 2





Rate of sedimentation of radioiodine with silver chloride in urine

and the liquid concentrated to a suitable bulk The concentrate (which contains halide other than iodide, and phosphate) may be used for re-administration after adjusting the *p*H, reducing the iodate to iodide with a little sulphur dioxide and flavouring It is perhaps preferable to carry out a final purification by distillation in the following manner The concentration process referred to above is carried on to about 30 ml To this a 100 per cent w/v solution of chromic acid (A R , 20 ml) is added, concentrated sulphuric acid (M A R , 60 ml) run in and the mixture heated to 180° C for a few minutes After cooling, water (30 ml) and oxalic acid (A R , 30 gm) are added and the flask connected to an all-glass distillation apparatus This should contain a still-head and a vertical delivery tube dipping into a tube receiver containing a few drops of 10 per cent sodium hydroxide in about 2 ml of water The flask is cautiously heated until reaction commences, and then heating is discontinued until the rather short and vigorous reaction which ensues is over Distillation is then carried out, when the radioiodine distils over rapidly and completely, about 20–30 ml of distillate is collected It gives no perceptible reaction with silver nitrate and is free from phosphate and sulphate The efficiency of the distillation process is 95 per cent or more

Table 2 shows a typical balance sheet of radioactivity obtained during a recovery process All activities are referred in time to the initial activity of the urine

The speed with which the recovery can be carried out is governed largely by the rate at which the silver halide gravitates after precipitation This is followed by removing samples of the supernatant liquid from a region just above the final level of the precipitate and determining their activity Such a sedimentation curve is shown in the accompanying graph

Note added in proof It is advisable to adjust the initial urinary *p*H to 5 by addition of concentrated hydrochloric acid This avoids the possible separation of calcium phosphate during the sedimentation of silver chloride, which interferes with the final distillation process

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[1] Baumann and Metzger, *J Biol Chem*, **121**, 231 (1937)

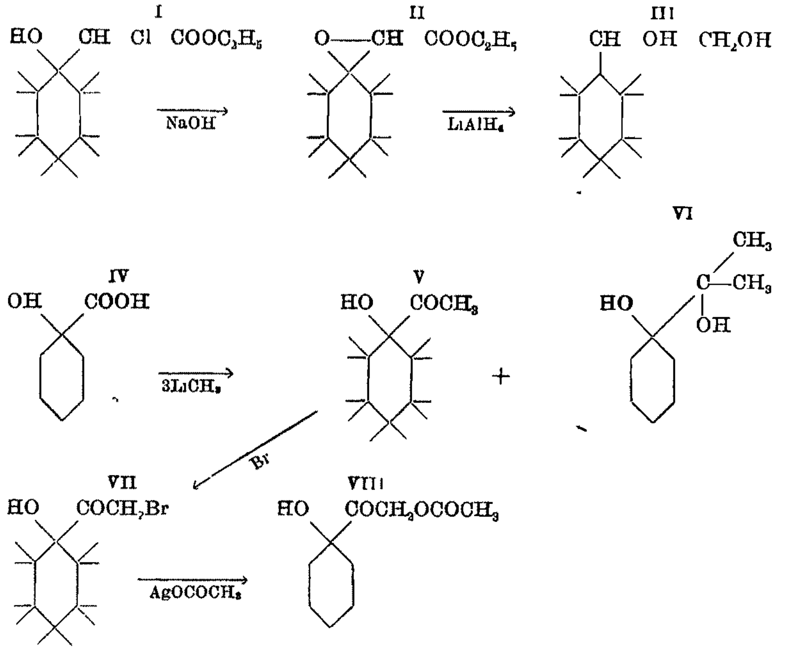
Simple Compounds with the Cortisone Side-chain

IN an attempt to prepare simple alicyclic analogues of cortisone, we have arrived at a novel route to the cortisone ketol side-chain Preliminary attempts met with early failure and one such failure is also described here

1-Hydroxy*cyclo*hexyl-ethylchloroacetate (I) was prepared by the Darzen reaction on *cyclo*hexanone The compound (I) on treatment with alkali under varying conditions led to the formation of the epoxide (II) The latter compound could not be hydrated under the usual hydrolysis conditions, and on reduction with lithium aluminium hydride resulted in the formation of *cyclo*hexylethylene glycol (III) Further methods of hydrating the compound (II) are under investigation

1-Hydroxy*cyclo*hexane carboxylic acid (IV), on treatment with lithium methyl (3 moles) in ether, resulted in the formation of 1-hydroxy*cyclo*hexylmethyl ketone (V, 46 per cent) The dimethyl carbinol (VI, 30 per cent) and unchanged acid (*c* 10 per cent) were also recovered Under carefully controlled conditions, we have been able to eliminate the formation of the undesirable carbinol (VI) and obtain the ketone (V) in 73 per cent yield

The ketone (V) was a liquid (b p $46°/10^{-6}$ mm) and was characterized as a semicarbazone crystallizing from ethyl alcohol as colourless cubes (m p 221°) and a 2 4-dinitrophenylhydrazone (m p 206°) The carbinol (VI) was obtained as colourless plates by



sublimation in high vacuum and crystallized from light petroleum ether as colourless plates (m p 83°)

The ketone (V) was brominated in warm chloroform and the bromo compound (VII) obtained as a pale yellow liquid (b p 88–90°/10^{-6} mm) The latter on treatment with silver acetate in boiling acetic acid was converted to the hydroxyketol acetate (VIII) The ketol acetate was obtained as a pale yellow liquid (b p 90–92°/10^{-6} mm), which on cooling set to an almost colourless solid which could be crystallized from petroleum ether as colourless rods (m p 42–43°) It was characterized as a semicarbazone (m p 172–73°) Methods of obtaining the ketol by direct oxidation of the ketone are being investigated

Further details will be published elsewhere One of us (J D B) is indebted to the Empire Rheumatism Council for financial assistance.

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Specificity and Mechanism of the Hunter Reaction for Ergothioneine

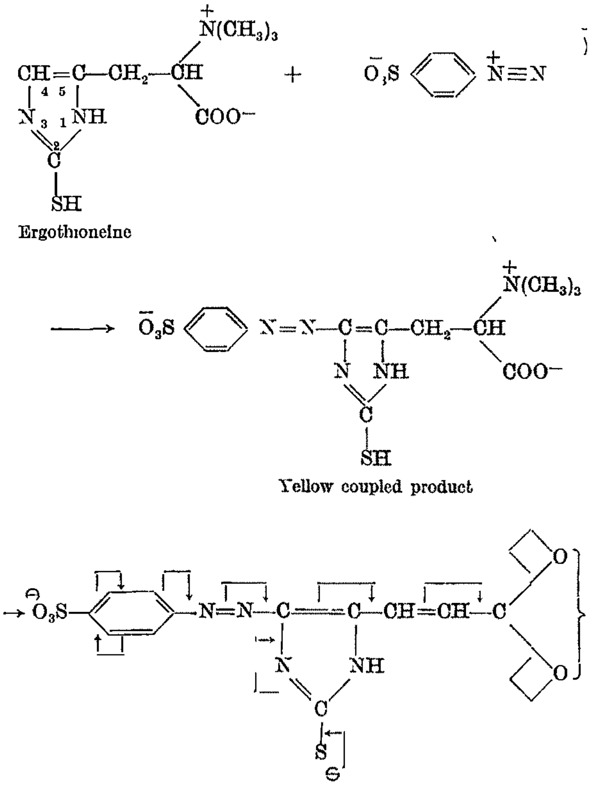
The deep magenta colour given by ergothioneine on treatment with buffered diazotized sulphanilic acid followed by 10 *N* sodium hydroxide has been used for the determination of ergothioneine in blood[1] The specificity of this reaction comes into question and has been considered by Hunter[2]

We have applied the Hunter reaction to a large number of 2-mercaptoimidazole derivatives Of those tested, only ergothioneine, 2-mercaptourocanic acid and 4-phenyl-2-mercaptoimidazole gave the deep magenta colour These were the only derivatives capable of producing highly conjugated coupling products (after loss of trimethylamine in the case of ergothioneine) with benzene diazonium chloride sulphonic acid All the other compounds tested gave at most a yellow to orange-red colour In the accompanying table the colours produced by a few typical members of the group are given

Compound	Colour with buffered diazo reagent	Colour on addition of 10 *N* sodium hydroxide 45 sec later
Ergothioneine	Yellow	Magenta
2-Mercaptourocanic acid	Red-blue	Magenta
4-Phenyl-2-mercaptoimidazole	Yellow	Magenta
2-Mercaptoimidazole	Yellow	Orange
4-Methyl-2-mercaptoimidazole	Yellow	Orange
4-Methyl-2-benzylmercaptoimidazole	Pale yellow	Pale yellow
4 5-Dimethyl-2-mercaptoimidazole	Yellow	Yellow
4-*p*-Hydroxybenzyl-2-mercaptoimidazole	Pale yellow	Pale red-orange
4-Methyl-5-carbethoxy-2-mercaptoimidazole	Pale yellow	Pale yellow (fading)
1-Methyl-2-mercaptoimidazole	Red orange	No increase in colour
2-Mercaptohistidine	Yellow	Orange

Mercaptourocanic acid on filter paper when sprayed with mixed diazotized sulphanilic acid–sodium acetate–carbonate reagent (*p*H about 9 4)[3] gives immediately an orange-red product, while ergothioneine gives a lemon-yellow product On spraying with the 10 *N* sodium hydroxide the mercaptourocanic acid spot turns the typical magenta to crimson colour immediately, but with ergothioneine the colour develops slowly, reaching a maximum after ten minutes The final magenta-coloured product from both substances appears to be the same, thus it begins to fade in about an hour, finally reaching a stable yellow colou The magenta substance is an indicator, turning yellow with acids and returning to magenta with alkalis, the *p*H of maximum colour change being in the region of 9 5–10 Thus, if the mercaptourocanic acid on filter paper is sprayed with a reagent of *p*H 9 7 instead of 9 4, the coloured spot immediately formed is noticeably more blue Similar results are obtained when the reaction is carried out in test-tubes

The following reaction mechanism for ergothioneine is suggested



Ergothioneine

Yellow coupled product

Magenta final product

The negatively charged sulphur atom resulting from ionization of the mercapto group in strongly alkaline solution probably contributes an electron pair which conjugates further with the system of double bonds, resulting in the enhancement of colou That this ionization is necessary is shown by the failure of S-methyl- and S-benzyl-mercaptoimidazoles to give any enhancement of colour on the addition of the caustic soda

The fact that 1-methyl-2-mercaptoimidazole gives a red colour with diazotized sulphanilic acid at *p*H 9 4 indicates that a free imino group may not be necessary[4] The possibility that the introduction of a nitroso group on the ring nitrogen is required for colour development is eliminated by our finding that the characteristic reaction for ergothioneine can be obtained when the usual diazo reagent is replaced by a solution of benzene diazonium chloride *p*-sulphonic acid free from nitrous acid

From the evidence above it appears that the substituents on position 4(5) of the mercaptoimidazole ing must have, or be capable of giving, a system f double bonds conjugated with the ring for the agenta colour to develop Ergothioneine is the nly substance known to occur in biological fluids hich meets these requirements[3]

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Hunter, G , *Biochem J* , **22**, 4 (1928), *Canad J Res* , **27**, E, 230 (1949)

Hunter, G , *J Chem Soc* , 2343 (1930)

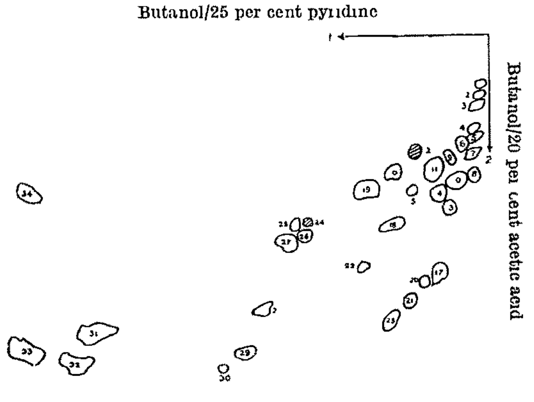
Lawson, A , Morley, H V , and Woolf, L I , *Biochem J* , **47**, 513 (1950)

f Fargher, R G and Pyman, F L , *J Chem Soc* , 217 (1919)

Autolysis Products of Pepsin

DURING the recrystallization of pepsin by the ethod of Northrop[1], which involves heating a solu- on of the enzyme to 45° C at *p*H 4, followed by oling, it was noticed that the warm solution de- osited a considerable quantity of needle crystals tally different from crystalline pepsin, these were lentified as tyrosine Continued autolysis under ese conditions yielded 35 mgm of tyrosine in 24 hr om 6 c c of a solution containing 1 0 gm of dry epsin This represents approximately 40 per cent the total tyrosine present Investigation of the alysed mother liquor by two-dimensional paper romatography[2,3] revealed the presence of at least irty-four ninhydrin-positive substances (see dia- am), many of which disappeared on acid hydrolysis, dicating that they are peptides It is suspected at some of the spots are simple amino-acids, as dicated by their position and speed of development mples of the autolysing solution taken at 5-min tervals during the first hour showed on paper romatography with butanol - acetic acid in one mension that a very complex pattern of spots is esent from the beginning, though extremely faint first Analysis in one dimension could not, of urse, decide whether the initial pattern contains l the thirty-four spots finally detected, but it is ovisionally concluded that the formation of the al fragments are not rate-determining steps

It was possible to isolate reasonably pure specimens the fragments Nos 1, 2 and 3 (see diagram) by multiple analysis in one dimension using butanol – acetic acid, the areas containing the peptides were detected under ultra-violet light and eluted with water Hydrolysis with $5\,N$ hydrochloric acid at 100° C for 24 hr followed by two-dimensional analysis showed that the amino-acids in the accompanying list were present 'Under-cystine' gives rise to a strong blue-mauve ninhydrin spot, it travels in butanol – 20 per cent acetic acid with the same speed as cystine, but is faster in butanol – 25 per cent pyridine, appearing between lysine and arginine 'Under-cystine' has not yet been identified, the speed with which it develops suggests that it is an amino-acid, though a resistant peptide cannot be excluded



Peptide No	1	2	3
'Under-cystine' (m w 120 ?)	(1)	(2)	(2)
Aspartic acid	(2)	(3)	(4)
Glutamic acid	(1)	(1)	(3)
Serine	(3)	(3)	(4)
Glycine	(2)	(2)	(2)
Alanine	(1)	(1)	(1)
Histidine	(1)	—	—
Arginine	—	(1)	—
Threonine	—	(1)	(2)
No of amino-acid residues	11	14	18
Provisional mol wt , approx	1,080	1,430	1,850

Careful examination of the size and intensities of the spots gave the provisional molecular ratios shown in the above table To confirm the identity of these constituents, the two-dimensional analysis was repeated with the addition of authentic samples of those amino-acids the presence of which was suspected and also cystine, with the exception of 'under-cystine', no extra spots were obtained

Treatment of ice-cold weakly acid solutions of the peptides with $0\,01\,N$ sodium nitrite followed by urea, hydrolysis and paper chromatography indicated that in all three cases alanine is the end amino-acid with the free amino-group, and that this occurs only once in these peptide molecules The provisional molecular weights given in the table follow from this result

The publication of this note is prompted by the temporary interruption of this work, it is hoped to continue and extend these experiments shortly I wish to acknowledge a grant from the Research Fund of the Chemical Society

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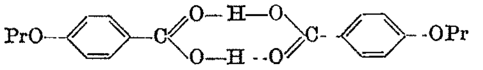
[1] Northrop, J , *J Gen Physiol* , 13, 739 (1930)

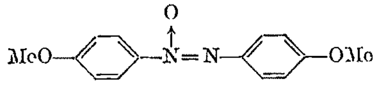
[2] Consden, R , Gordon, A H , and Martin A J P *Biochem J* , **38**, 224 (1944)

[3] Worwod, A J , *J Gen Microbiol* , 3, 312 (1949)

Mesomorphism of some Alkoxynaphthoic Acids

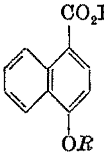
THE existence of mesophases in the melts of *p*-*n*-alkoxybenzoic and *p*-*n*-alkoxycinnamic acids has already been established[1,2] In these acids the length of the rod-shaped molecules is enhanced by hydrogen-bond formation, and the mesomorphism arises from the association of the acids in double molecules In this way, *p*-*n*-propoxybenzoic acid, which has the simplest molecular structure yet found to give a mesomorphic form, acquires a structure which is similar in length and shape to that of a typical nematic compound, such as azoxyanisole





The structural features necessary for the occurrence of double refraction in a liquid have been discussed by Vorlander, but the relative importance of length and flat-area as factors in bringing about this phenomenon is not clear It is well known that the cholesteryl esters of the saturated fatty acids exhibit marked mesomorphism

In an attempt to determine more clearly the significance of these factors, the study of the alkoxy-aromatic carboxylic acids has been extended to 4-n-alkoxy-1-naphthoic and 6-n-alkoxy-2-naphthoic acids, and some twenty-six of these acids have been synthesized and examined



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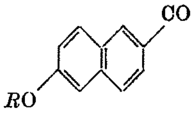

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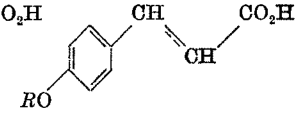

III

Of the thirteen 4-n-alkoxy-1-naphthoic acids (I) prepared, none shows mesomorphism ($R = CH_3$ to $C_{10}H_{21}$, $C_{12}H_{25}$, $C_{16}H_{33}$ and $C_{18}H_{37}$) The first members of this series ($R = CH_3$ to C_8H_{17}), like p-methoxy- and p-ethoxybenzoic acids, melt at temperatures above 180° C, but the melting points of the higher members are much lower The absence of mesophases in these acids may be due to the fact that the broad naphthalene nuclei, lying at right angles to the long axis of the dimerized molecules, prevent them from orientating themselves in such a way that mesomorphism becomes possible It is significant in this connexion that the introduction of chlorine atoms into the ortho-positions of p-n-amyl-oxybenzoic acid destroys its mesomorphism

Unlike the 4-n-alkoxy-1-naphthoic acids, the isomeric 6-n-alkoxy-2-naphthoic acids (II) show mesophases In the case of twelve of the thirteen acids prepared ($R = CH_3$, C_2H_5, C_4H_9 to $C_{10}H_{21}$, $C_{12}H_{25}$, $C_{16}H_{33}$ and $C_{18}H_{37}$) the mesomorphism is readily observed, but with the n-propoxy- acid the temperature-range of the nematic form is only a fraction of a degree A nematic phase only is found in the first nine members of this series, the temperature-range of which reaches a maximum of 49° in the hexyloxy- acid With the decyloxy- acid a smectic phase appears, the nematic henceforth becoming less pronounced as the length of the alkyl group is increased These 6-n-alkoxy-2-naphthoic acids, which show structural similarities to the *trans* p-n-alkoxy-cinnamic acids (III), are long molecules without the breadth found in their isomers of structure (I), and therefore able to orientate themselves so that mesomorphism can occur

Examples of mesomorphism in naphthalene compounds are not common, the best known are the anils of 2 6-diaminonaphthalene, but Vorlander[3] has shown that certain 1 4-disubstituted naphthalene systems exhibit mesomorphism These, however, are resins or lacquers, such as anisal-1-amino-naphthalene-4-azobenzene In such complex structures the broad naphthalene nucleus is near the centre of the molecule and, as a result, is probably of less importance than it is in the dimerized 4-n-alkoxy-1 naphthoic acids

In view of the difference in behaviour betwee the 4-n-alkoxy-1-naphthoic and the 6-n-alkoxy-2 naphthoic acids, the properties of the 5-n-alkoxy-1 naphthoic acids may be of particular interest

A fuller account of these investigations will b published elsewhere In the meantime, other serie of compounds are being examined

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Sept 12

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[1] Jones, Brynmor, *J Chem Soc*, 1874 (1935)

[2] Bennett and Jones, Brynmor, *J Chem Soc*, 420 (1939)

[3] Vorländer, *Trans Farad Soc*, 899, 907 (1933)

Antihistamines and Thyroxine Metamorphosis in Tadpoles

SZEBEHELY and co-workers[1] ascertained that in mic desensitized with histamine the basal metabolic ra rose much less after thyroxine administration than mice not so desensitized Antihistamines were to toxic, and so they could not demonstrate convincingl that their effect was similar to that of histamin desensitization

Using tadpoles, we have been able to show definite antagonism between the antihistamin benzhydryl - β - piperidinoethylether hydrochlorid (Spofa III 101) and thyroxine 120 tadpoles (*I temporaria*) were equally divided into four tanks co taining 1,000 c c water at 20° C The water wa ventilated with air The animals were fed with drie heart muscle The water was changed daily, and th drugs used were added freshly every day. Th experiment lasted twenty-seven days The dru were added as follows

Group I Controls

Group II Thyroxine 6th–11th day (20 μgm p 1,000 c c water daily)

Group III Thyroxine 6th–11th day (20 μgm p 1,000 c c water daily) and antihistamine 1st–27 day (2 mgm per 1,000 c c water daily)

Group IV Antihistamine 1st–27th day (2 mg per 1,000 c c water daily)

On the twenty-seventh day the thyroxine-treate animals (group II) had well-developed hind and fro legs and a largely atrophied tail The control ta poles (group I) were more than twice as large, b only the buds of their hind legs were just visib The tadpoles treated with both antihistamine a thyroxine (group III) were about twice as large those treated with thyroxine only, and although th hind legs were partly developed there were no sig of any front legs Their tails had not started atrophy The animals in group IV seemed at the sa stage of development as the control animals, b later on they showed signs of slowed-down met morphosis Thus we showed that the antihistami drug Spofa III 101 clearly inhibits the effect thyroxine and also slows down the spontaneo metamorphosis of tadpoles

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Sept 12

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[1] Szebehely *et al*, *Nature*, 165, 153 (1950)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 15

Society of Chemical Industry, Food Group (joint meeting with the Liverpool Section, at Radiant House, Bold Street, Liverpool), at 2 30 p m —Discussion on "The Marine Transport of Food"

Chemical Society, Sheffield Section (in the Chemistry Lecture Theatre, The University, Sheffield), at 5 30 p m —Prof Dr K Linderstrøm-Lang "The Structure and Breakdown of Enzymatic Proteins"

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5 30 p m —Prof E D Adrian, O M, F R S "Sleep" (Wilde Memorial Lecture) *

University of London (at Bedford College for Women, Regent's Park, London, N W 1), at 5 30 p,m —Prof H Munro Fox, F R S "The Zoogeography of Land Animals" * (Further Lectures on January 22, 29, February 5, 12 and 19)

University of London (at the Institute of Education, Malet Street, London, W C 1), at 5 30 p m —Dr E S Biesheuvel "The Study of African Abilities" * (Further Lectures on January 17 and 22)

Institute of Fuel (at King's College, Newcastle-upon-Tyne), at 6 30 p m —Papers on "Drying of Fuel, Sand, etc " *

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 15 p m —Prof H C Darby "The Changing English Landscape"

Tuesday, January 16

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —Mr Malcolm Lomberg "Rehabilitation of Native Reserves in South Africa"

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr C O Carter "Congenital Malformations" *

Institution of Civil Engineers (at Great George Street, London, S W 1), at 5 30 p m —Prof A G Pugsley "Concepts of Safety in Structural Engineering"

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr R H Dolton "The Application of High-Speed Centrifuges in the Chemical and Process Industries"

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Prof R L Wain "Plant Growth-Regulating Activity in the Aryloxyaliphatic Acids" *

Society of Chemical Industry, Manchester Section (in the Chemistry Lecture Theatre, The University, Manchester), at 6 30 p m —Prof H R Kruyt "The Relation between Pure and Applied Science" (Jubilee Memorial Lecture) (Members of the Chemical Society and the Royal Institute of Chemistry are invited)

Society of Chemical Industry, Plastics and Polymer Group (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 6 30 p m —Dr T T Jones "The Melt-Viscosity of some Phenol-Formaldehyde Novolac Resins"

Textile Institute (at 16 St Mary's Parsonage, Manchester), at 6 30 p m —Miss D M Hannah "High Drafting (with special reference to the Ambler Superdraft System)"

Textile Institute, Scottish Section (joint meeting with the East of Scotland Section of the Institution of British Launderers, at the North British Hotel, Edinburgh), at 7 30 p m —Mr C A Norris "Synthetic Detergents"

Wednesday, January 17

Institute of Fuel, North-Western Section (at the Engineers Club, Albert Square, Manchester), at 2 p m —Mr F B Karthauser "Developments in the Utilization of Low Grade Fuels at Collieries"

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Rt Hon Lord McGowan "1851–1951, a Century of British Industry"

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W C 1), at 5 30 p m —Annual General Meeting, Dr G M Findlay "The Virus and the Cell" (Presidential Address)

Illuminating Engineering Society (at the Royal Institution, 21 Albemarle Street, London, W 1), at 6 p m —Dr J W T Walsh "The Early Years of Illuminating Engineering in Great Britain" (Trotter-Paterson Memorial Lecture) *

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W C 2), at 6 p m —Discussion on "Electric Wave Filters" (to be opened by Mr F E Rogers)

Society of Instrument Technology, Control Section (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 30 p m —Discussion on "Nomenclature" (to be opened by Dr J C Evans)

British Institution of Radio Engineers, South Midlands Section (in the Exhibition Gallery, Public Library, Rugby), at 7 p m —Dr B E Noltingk "Ultrasonic Generators for High Powers"

Institute of Petroleum, Stanlow Branch (at the Grosvenor Hotel, Chester), at 7 15 p m —Annual General Meeting, at 8 15 p m —Mr M A L Banks "Refinery Considerations"

Thursday, January 18

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Mr T A A Quarm "A Method for the Preparation of High-purity Indium Metal", Messrs D W Hopkins and A G Adlington "Factors affecting the Reduction of Zinc Oxide by Carbon" and "A Study of the Reduction of Zinc Metaferrite by Carbon", Dr R A Mackay "The Detection of Columbite by Ultraviolet Light"

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof J L B Cooper "Heaviside and the Operational Calculus"

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 15 p m —Dr F Bergel "Physico-Chemical Properties and Pharmacological Activity of Drugs" * (Further Lecture on January 25)

Physical Society, Acoustics Group (in the Henry Jarvis Hall, Royal Institute of British Architects, 66 Portland Place, London, W 1), at 5 30 p m —Mr W A Allen and Mr Hugh Creighton "The Arrangement of Large Orchestras and the Design of Concert Platforms"

University of Manchester Chemical Society (joint meeting with the Local Section of the Chemical Society, in the Chemistry Lecture Theatre, The University, Manchester), at 6 30 p m —Prof R P Linstead, F R S "Some Recent Developments in Macrocyclic Pigments"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Prof K Linderstrøm-Lang "Structure and Enzymatic Breakdown of Proteins" (Centenary Lecture)

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W 1), at 7 30 p m —Prof René Mouchet "The Work of the FOREAMI (Fonds Reine Elisabeth pour l'Assistance Médicale aux Indigènes) in the Belgian Congo"

Friday, January 19

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Lieut -Comdr P G. Satow "Submarine Navigation"

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p m —Mr W H Purdie "Thirty Years' Development of Opposed-piston Propelling Machinery" (Thomas Lowe Gray Lecture)

Manchester Statistical Society, Statistical Methods Study Group (at the Albert Hall, Peter Street, Manchester), at 5 30 p m —Mr Dudley Seers "Redistributing Income in the Post-War Period".

Society of Dyers and Colourists, Manchester Section (at the Gas Showrooms, Town Hall Extension, Manchester), at 6 30 p m —Dr G T Douglas "Continuous Fixation Processes for Water-Soluble Dyestuffs"

Geographical Association, Manchester Branch (in the Geography Room, Central High School for Boys, Whitworth Street, Manchester), at 6 p m —Annual General Meeting, at 7 p m —Mr J H. McD Whitaker "The Red Rocks of Cheshire"

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 7 p m —Discussion on "Methods of Reduction"

Saturday, January 20

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 10 30 a m —Discussion on "The Comparative Merits of Animal and Vegetable Food in Nutrition"

British Psychological Society (in the Eugenics Theatre, University College, Gower Street, London, W C 1), at 2 30 p m —Prof C A Gibb "An Experimental Approach to the Problems of Leadership"

British Interplanetary Society, North-Western District Centre (at the Adult Education Institute, 49 Lower Mosley Street, Manchester), at 7 p m —Mr A C Clarke "The Challenge of the Spaceship"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Head of the Instrument Division—The Director, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N W 7 (January 18)

Principal Scientific Officer at the Atomic Energy Research Establishment, Harwell, Didcot, to take charge of a small group engaged in problems of heat transfer, and special problems arising in the development of nuclear energy for power purposes, involving design of special experimental apparatus—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting 3410 (January 18)

Analyst (including micro-analysis) for the Chemistry Department—The Secretary, The University, Aberdeen (January 19)

Child Guidance Psychologist—The Chief Education Officer County Hall, Wakefield (January 20)

Investigational Officer/Clerk Accountant (with a diploma in agriculture or an equivalent qualification) in the Department of Economics, Bristol II Provincial Agricultural Economics Centre, Newton Abbot—The Registrar, The University, Bristol (January 20).

Lecturer in Mathematics—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (January 20)

Organic and Plant Chemists (Experimental Officer grade) by the Ministry of Supply —Organic Chemists with ability to carry out organic preparative work, Plant Chemists (Chemical Engineers) with experience in preparative work, employing technical or large-scale equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 745/50A (January 20)

Physicists (Scientific Officer grade) at Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 310/50A (January 20)

Area Chief Engineer (Mechanical and Electrical) at No 3 Area—The Area General Manager, National Coal Board, Northern (N and C) Division, No 3 Area, Colliery Offices, Ashington Northumberland, endorsed V 1 (January 22)

Honours Graduate (Chemistry or Physics) or other suitably qualified person, to be trained in Electron Microscopy—The Secretary, The University, Aberdeen (January 22)

Assistant Keeper in Botany in the Manchester Museum—The Registrar, The University, Manchester 13 (January 24)

Chemical Engineer in the Department of Industries, Ceylon—The High Commissioner for Ceylon in the United Kingdom, 13 Hyde Park Gardens, London, W 2 (January 24)

Assistant Keepers (second class) in the Science Museum, one in the Department of Astronomy and Geophysics, and one in the Department of Motive Power and Industries—The Secretary, Civil Service Commission Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3416 (January 25)

Senior Principal Scientific Officer or Principal Scientific Officer to assist in the general administration of the Royal Greenwich Observatory, Herstmonceux, to supervise and participate in programmes of observation, and to undertake the reduction, analysis and discussion of observations—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3420 (January 25)

Senior Agricultural Economist at Bristol, an Agricultural Economist at Bristol, Assistant Agricultural Economists (2) at Bristol, and Assistant Agricultural Economists (2) at Newton Abbot—The Registrar, The University, Bristol (January 26)

Senior Assistant Analyst, and an Assistant Analyst, for the County Laboratory—The County Medical Officer of Health, County Offices, Preston (January 27)

Metallurgists (Scientific Officer grade) in a Ministry of Supply Experimental Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 761/50A (January 28)

Assistant Analytical Chemist (with at least the B Sc degree in chemistry) in the Government Analyst's Laboratory in Salisbury—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W C 2 (January 30)

Principal Scientific Officer at the Atomic Energy Research Establishment, Harwell, to lead a team engaged on problems of fundamental chemical engineering interest—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3430 (January 30)

Senior Scientific Officer at the Fire Research Station, Boreham Wood, Elstree—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3424 (January 30)

Geologists (2) whose main duties will be the making of photogeological maps from vertical air photographs under the direction of the Principal Geologists—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting G 333/50A (January 31)

Lecturer in Pathology, with particular interests in hæmatology, a Lecturer in Clinical Biochemistry, and a Senior Lecturer or Lecturer in Radiology, in the Faculty of Medicine, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (January 31)

Lecturer in Physiology—The Registrar, The University, Leeds 2 (January 31)

Principal of the School of Agriculture for Girls, Department of Agriculture, Ceylon—The Office of the High Commissioner for Ceylon in the United Kingdom, 13 Hyde Park Gardens, London, W 2 (January 31)

Research Fellowship in Photographic Science—The Secretary, Imperial College of Science and Technology, Prince Consort Road, London, S W 7 (January 31)

Senior Experimental Officers and Experimental Officers—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3351 (January 31)

University Graduate (with first- or second-class honours) to take charge of the X-ray Section of the Department of Pedology—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (January 31)

Veterinary Officers (about 43), and Research Officers (about 13), in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 3426 (January 31)

Chemical Engineers (Principal Scientific Officer grade) in a Ministry of Supply Research and Development Establishment (initially in N W England)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3428 (February 1)

Engineers (Principal Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough, Hants, for research into the fatigue of aircraft structures—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 667/50A (February 1)

Senior Lecturer in the Department of Physics, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (February 1)

Assistant in the Department of Technology—The Directo Royal Scottish Museum, Edinburgh 1 (February 3)

Electronic Physicists and Engineers (Scientific Officer grad at Ministry of Supply Research and Development Establishmen mainly in the south of England—The Ministry of Labour and Nation Service, Technical and Scientific Register (K), York House, Kingswa London, W C 2, quoting A 311/50A (February 8)

Senior Research Officer or Research Officer, Fibre Physi (Ref No 3159), a Senior Research Officer or Research Office Fibre Assemblies (Ref No 3160), and a Senior Research Offic or Research Officer, Engineering (Ref No 3161), in the Wo Textile Research Laboratories, Sydney—The Chief Scientific Liais Officer, Australian Scientific Liaison Office, Africa House, Kingswa London, W C 2, quoting the appropriate Ref No (February 9)

Biochemist in the Endocrine Unit—The Secretary, Lond Hospital, Whitechapel, London E 1 (February 10)

Lecturer in Educational Psychology—The Registrar, Unive sity College, Hull (February 10)

Senior Lecturer in Electrical Engineering in the Universi of Sydney—The Secretary, Association of Universities of the Britis Commonwealth, 5 Gordon Square, London, W C 1 (February 12)

Colonial Liaison Officer at the Pest Infestation Laborator Slough—The Ministry of Labour and National Service, Technic and Scientific Register (K), York House, Kingsway, London, W C quoting G 352/50A (February 16)

Readership in Zoology at King's College of Household and Soci Science—The Academic Registrar, University of London, Senat House, London, W C 1 (February 16)

Senior Lecturers, Lecturers, or Assistant Lecturers, i (*a*) Agricultural Entomology and (*b*) Plant Pathology, a University College, Ibadan, Nigeria—The Secretary, Inter-Universit Council for Higher Education in the Colonies, 1 Gordon Square, Lon don, W C 1 (February 17)

Readership in Anatomy at St Bartholomew's Hospital Medic College—The Academic Registrar, University of London, Senat House, London, W C 1 (February 21)

I C I Research Fellowships in Biochemistry, Chemistry Engineering, Pharmacology or Physics—The Secretary of Unive sity Court, The University, Glasgow (February 28)

Lecturer in Farm Machinery—The Registrar, King's Colleg Newcastle-upon-Tyne (February 28)

Lecturer in Geology, with special reference to petrology—Th Secretary, Queen's University, Belfast (February 28)

Principal of the National College of Food Technology—The Secretary (F E Branch, Division IIIa), Ministry of Education Curzon Street, London, W 1 (February 28)

Professor of Philosophy at the University of the Witwatersrand Johannesburg—The Secretary, Association of Universities of th British Commonwealth, 5 Gordon Square, London, W C 1 (Februar 28)

Senior Lecturer in the Department of Geography, Universit of Otago, Dunedin, New Zealand—The Secretary, Association o Universities of the British Commonwealth, 5 Gordon Square, London W C 1 (February 28)

Professorship in the Department of Physics—The Registrar University of Manitoba, Winnipeg, Canada (March 31)

Senior Lecturer in Physical Metallurgy at the University o Melbourne—The Secretary, Association of Universities of the Britis Commonwealth, 5 Gordon Square, London, W C 1 (March 31)

Aeronautical and Mechanical Engineers (Scientific Office grade) in Ministry of Supply Research and Experimental Establishments mainly in the south of England—The Ministry of Labour an National Service, Technical and Scientific Register (K), York House Kingsway, London, W C 2, quoting C 659/50A

Assistant Civil Engineer in the Department of Drainage and Irrigation, Malaya—The Director of Recruitment (Colonial Service) Colonial Office, Sanctuary Buildings, Great Smith Street, London S W 1 quoting No 27329/24

Assistant Horticultural Officer (male), with a University degree or diploma in horticulture and, preferably, some experience of commercial vegetable growing and/or vegetable seed production—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Deputy Chief Metallurgist by the Division of Atomic Energy (Production), to be responsible for the layout of development laboratories, including large-scale and pilot plant and small-scale laboratory facilities at Springfields Salwick, near Preston—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

Divisional Chief Analyst in the Scientific Branch—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1

Exchange Fellowships in Cancer Research offered by the National Cancer Institute of Canada and the American Cancer Society—The Secretary-General, British Empire Cancer Campaign, 11 Grosvenor Crescent, London, S W 1

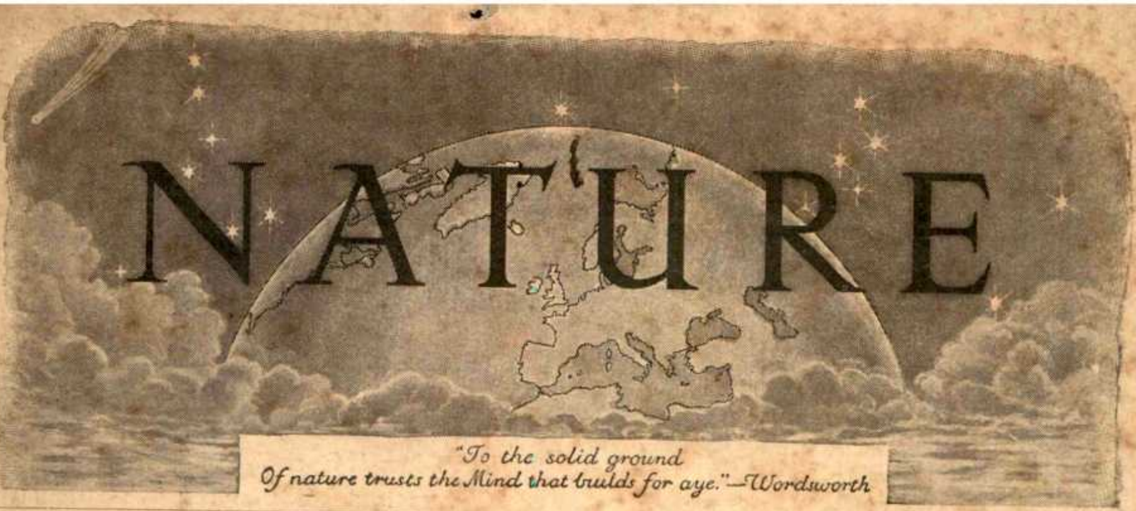
Mathematicians (Scientific Officer grade) in Ministry of Supply experimental establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 355/50A

Physical Chemist (Senior Scientific Officer grade) experienced in conducting research investigations—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, Hendon, London, N W 4

Research Officer (Forest Chemist) in the Forestry Department, Federation of Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27106/45

Scientific Assistant (man or woman) to join team on information service and producing abstracting journal—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading, Berks

Senior Meteorological Officer and Meteorological Officers (3) in the Civil Aviation Department, Northern Rhodesia—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings Great Smith Street, London, S W 1, quoting No 27118/14



NATURE

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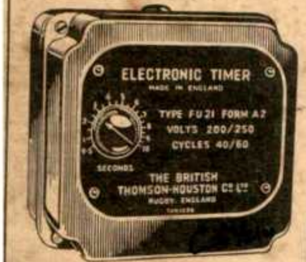

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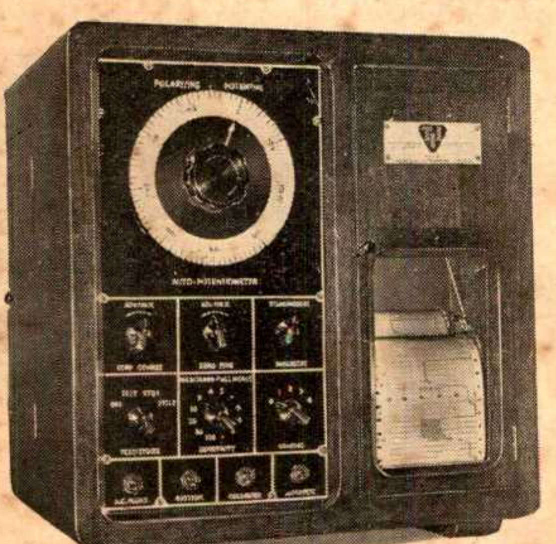

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NATURE

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STATE DEVELOPMENT OF INVENTIONS

THE National Research Development Corporation was set up under the Development of Inventions Act, 1948, to secure the development in the public interest of inventions resulting from public research which, in the Corporation's judgment, are not being sufficiently exploited, and to hold and dispose of rights in inventions arising from such research At the time, misgivings were felt about its possible effect on the general research organization in Great Britain, but a perusal of the first annual report recently issued* should allay them All the evidence put forward in this report suggests that the Corporation is likely to strengthen rather than weaken the nation's research structure, and its operations have so far been handled with a wise judgment that has enlisted the co-operation and support of the numerous organizations with which it has had to work A start has been made which should secure even wider public support as the Corporation becomes better known

It is not, indeed, possible to judge from this first report how far the real need for such a Corporation has been proved, the information given under dealings in inventions is naturally too meagre for any such purpose A fuller analysis and more detail will doubtless be supplied in subsequent reports, when with the lapse of time the consideration of prejudicing negotiations no longer applies On this point, however, there is a suggestion made in the recent report of the Interdepartmental Committee on Social and Economic Research, which, if implemented, might help to supply decisive evidence A survey of the material available in the Patent Office has impressed the Interdepartmental Committee with the opportunity for useful research which such material presents In particular, it suggests investigation of such questions as the relations between inventions and the trade cycle, and, on a sample basis, into the number of inventions which are not exploited and the reasons why they are not developed If examination of this material at the Patent Office indicated, for example, how many projects failed through lack of financial resources and how many were modified or superseded, an independent pointer to the value of the Corporation's work here might be forthcoming in support of the data already accumulated

Any such investigation would require to be followed up, as the Interdepartmental Committee recognizes, and such follow-up clearly falls within the purview of the Corporation, which might also well be associated with any such inquiry from the start The suggestion is one that should be carefully considered by the Corporation, and might well fall within the scope of the co-operation with the Board of Trade already established by the Corporation

The main concern of the Corporation during its first year has been to establish satisfactory arrangements with the bodies from which it may expect to receive inventions for development and exploitation Arrangements have been concluded with government departments for the transfer to the Corporation of departmental and public rights in inventions, and some inventions were already being dealt with by the end of the year

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* National Research Development Corporation Report and Statement of Accounts for the Period 28th June 1949 to 30th June 1950 Pp 20 (London H M Stationery Office, 1950) 6*d* net

Sensible but less formal arrangements have been established with the Medical Research Council, the universities, the industrial research associations and with a number of other organizations, including the Nuffield Foundation The research associations are expected to be a particularly rich source of inventions, and rights in such inventions as they may make belong unquestionably to their members The Corporation, together with the Department of Scientific and Industrial Research and each of the individual associations, has carefully considered the question of assisting each association to utilize to the fullest extent the possibilities of any of its inventions, and it is clear from this examination that the Corporation has the goodwill of the research associations

In relations with the Medical Research Council, the first consideration has been to preserve the intellectual, academic and ethical freedom of research workers, who have a long tradition of abstention from patenting discoveries in the medical field No formal agreement has been made for the time being between the Corporation and the Council, although arrangements are in hand for transfer to the Corporation of the patent rights in a number of inventions made by workers responsible to the Council Furthermore, in this same field the British Medical Association has recognized the Corporation as providing the system of dedicated patents suggested in 1932 Accordingly, it has recorded its opinion that there is no longer any objection to the patenting of inventions for which members of the medical profession are responsible, provided such patents are assigned to the National Research Development Corporation with a view to their administration in the best interests of the public as a whole

In this field, the Corporation has thus been definitely recognized as a link between the research worker and the industrialist The same conception is implicit in the arrangement established between the Corporation and the universities The Corporation considers that it would be contrary to the general spirit of academic freedom to regard the contributions of the University Grants Committee—or of the Department of Scientific and Industrial Research—to university finance as grounds for the automatic transfer of title in inventions from university governing bodies to the Corporation It proposes to rely instead on voluntary co-operation, but in view of the wish which many university workers immediately expressed to assign their inventions to the Corporation, the Corporation considered it essential that the plans and policies contemplated to secure co-ordination, particularly with respect to the monetary rewards which should accrue to the inventor of a device successfully developed under the Corporation's sponsorship, should have the complete approval of governing bodies

As a result of lengthy discussions, a document has been drawn up which sets forth the functions of the Corporation in relation to the universities in the United Kingdom This has been sent, with the approval of governing bodies, to all workers in the universities and university colleges of the United Kingdom, and has already resulted in the submission to the Corporation of a number of interesting inventions This document is appended to the report, and it explains just how the problem arises of maintaining the free publication, which is in the best tradition of university science, while ensuring that all important inventions arising in universities are protected by patents with the minimum distraction to the research worker, with no delay in publication and without financial, administrative or supervisory burden upon individuals or the institutions

These last are responsibilities of the Corporation, and in fulfilling them the Corporation hopes to gain acquaintance with the work of the scientific and technical departments of the universities, particularly with work likely to lead to industrially useful inventions It wishes to build up friendly relations for this purpose, as well as to offer to apply for patents assignable to the Corporation, in consultation with the departments and research worker concerned, for such inventions as appear to the Corporation to warrant protection by patenting In such activities the Corporation will be specially concerned to see that the administrative work involved in liaison and patenting does not interfere with prompt publication of laboratory results in the usual scientific journals, and that, where the merit of an invention is attributable to an individual, the individual's name is duly associated with the invention Care will also be taken to avoid destroying satisfactory contacts which already exist between a university and an industry

So far as the universities are concerned, the National Research Development Corporation is thus proposing to act on an informal basis, much as the patents department of a large industrial firm. Details given in the report are insufficient to judge whether the technical, industrial and patents divisions are adequately staffed for the purpose Much will obviously depend on the Corporation being able to recruit men of sufficient experience and sound judgment, as well as of appropriate professional qualifications, for these purposes, and only time can show how far it has succeeded in this respect The Corporation is not, indeed, attempting to provide all the necessary assessment of inventions from its own internal resources So far as technical merit is concerned, first-class advice can usually be readily obtained from the government laboratories and research stations, or from the universities and industrial research associations The Corporation is also setting up advisory panels drawn from experts in various groups of industry to advise it on the technical and industrial merits of inventions submitted to it

Already the Corporation has noted that too many private inventors devote energy and effort to devising inventions which industry either does not want or cannot use without complete dislocation or recon struction In contrast, the three inventions, out of 485 submitted from private sources, which the Corporation selected as meriting public support, were all the designs of qualified engineers with experience in the inventive field to which they had directed their attention

So far as the development of inventions is concerned, it is too early yet to judge whether sufficient financial resources are at the disposal of the Corporation For most of the public inventions handled by the Corporation, it is anticipated that the Corporation will be concerned solely with the development of the invention on terms which will make its introduction into industrial practice attractive Where a development stage has to be contemplated involving use of the Corporation's financial resources, it has been agreed with the Board of Trade, under the Development of Inventions Act, that a limited liability company will be set up, to be owned jointly by the inventor and the Corporation, on terms securing to the Corporation full control over the affairs of the company

The report also discusses in some detail the principles involved in the exploitation of inventions The conflict between the relative advantages and disadvantages of the exclusive and non exclusive licensing policy is regarded as one which can only be resolved in practice by assessing the balance of public interest in each particular case Further, the Corporation does not wish to discourage the collaboration which has frequently existed between many manufacturers and academic men of science, if the latter now assign their rights in their inventions to the Corporation, the firm concerned would normally be given such initial advantages and exclusiveness in the manufacture of the invention as are consistent with the public interest The exploitation of inventions relating to food, medicines and surgical or curative devices will, however, be carried out on lines which conform to the intentions of Section 41 of the Patents Act, which requires the Comptroller-General of the Patent Office to grant licences for inventions in this field to all applicants unless, in his opinion, there are good reasons for not doing so

In this report the Corporation itself recognizes that it is too early to say whether certain fears are justified which were expressed in Parliament during the debates on the passage of the Act, for example, that the Corporation might find it impossible to discharge satisfactorily and simultaneously the three duties laid upon it by the Development of Inventions Act This first account of its activities, however, shows clearly that, under the chairmanship of Sir Percy Mills, the Corporation has made a good start in a difficult field By the exercise of good sense and judgment, it has already won a degree of goodwill and co-operation that promises well for the future Provided its technical staff prove to possess the requisite experience and judgment, there seems every reason for confidence that the Corporation will conduct its affairs so as to secure at least that it acts in the public interest, and collaborates, rather than competes, with existing industries By winning the public support which enables it to discharge these two duties, the Corporation should be far on the way towards securing whatever further financial resources may possibly be required to enable it to discharge its full responsibilities when the actual development and exploitation of inventions by the Corporation increase

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CHAMBERS'S ENCYCLOPÆDIA: PHYSICAL SCIENCES

Chambers's Encyclopædia

New edition Vol 1 A–Autonomy Pp xix+848 Vol 2 Autun–Camorra Pp xv+816 Vol 3 Camouflage–Confession of Faith Pp xiv+840. Vol 4 Confirmation–Educational Psychology Pp. xv+820 Vol 5 Edward–Franks Pp xiv+856. Vol 6 Franquelin–Heine Pp xv+824 Vol 7: Heinrich–Izvolsky Pp xiv+820 Vol 8 J–Majesty Pp xv+840 Vol 9 Major–New York. Pp xv+856 Vol 10 New Zealand–Pola Pp. xv+824 Vol 11 Poland–Rosicrucians Pp xv+840 Vol 12 Roskilde–Spahi Pp xv+796 Vol. 13 Spain–Tsushima Pp xv+792 Vol 14 · Tuamoto–Zygote Pp xiv+856 Vol 15 Indexes and Maps Pp x+815 (London George Newnes, Ltd, 1950) 15 vols, £42 10*s* 0*d*

EVERY research worker knows how essential it is to pause every now and then to sum up the work so far accomplished, and perhaps also to review *ab initio* the particular problem to which he is devoting his attention It is not sufficient to consider fresh information It must be correlated with what is already known on the subject, and due weight given to each item In addition, it may be necessary to consider the general background and history of the subject, and it would be unwise to ignore completely the possible implications to, and applications in, other branches of science and everyday life As a result of such a survey, new interesting problems may present themselves, or, alternatively, fresh inspiration and encouragement may be needed For accurate data, reference must be made to the reports of the original investigations, for inspiration and encouragement, to the descriptions of the pioneering works and fundamental discoveries of the acknowledged great masters of science, and for details of the history, general background and practical applications of his subject, to numerous sources covering a very wide range of literature. To assist him in his task, the research worker thus tends more and more in these days to turn to authoritative summaries, digests and up-to-date progress reports on the topics in which he is interested

Consider now the case of the layman, albeit the intelligent, average educated layman Whereas the research worker is concerned primarily with only a particular restricted field of inquiry and has usually a specialized training and knowledge, the layman may be called upon from time to time to obtain exact and detailed information, not in one restricted field alone but in many, on subjects covering all phases of human thought and endeavour Even if all the sources were immediately available, without considerable assistance the task of combing through the literature for the required information would be an impossible one For one thing, the various technical and other jargons, in which, regrettably, far too much of the modern work is expressed, would be unintelligible and an almost impassable barrier to progress. Fortunately, for the layman as for the research worker, the necessary assistance has been long provided in the form of that adequate, easily consulted, 'digest of all libraries', the encyclopædia.

During the past 100 or 150 years, several notable encyclopædias in the English language have been published. Of these, "Chambers's" has for a long time been regarded as one of the best. The first edition of "Chambers's" appeared during 1859–68, and was published in 520 weekly parts at the remarkable price of three half-pence each. "Chambers's" has since then run through several editions, which, by careful pruning and revision but without sacrifice of standard, have managed to continue to represent the ever-expanding knowledge of the times, in the most modern fashion, without increasing the number of the original ten volumes. The last ten-volume edition appeared in 1935.

The Second World War, however, ushered in a new period of political, social, economic, and scientific and technical development, and it was inevitable, therefore, that when, in 1944, a new edition of "Chambers's" was contemplated, a mere revision of the 1935 edition was rejected as useless. The task of planning the new encyclopædia was entrusted to Mrs. M. D. Law, who became the managing editor, and who, in the initial stages, had the assistance of such well-known men as Sir Henry Dale, Sir Richard Gregory and Dr. G. M. Trevelyan. The final work is the result of the combined labours of Mrs. M. D. Law, fifty-two advisory editors, nine technical assistant editors, and more than two thousand individual contributors. Not only is the new edition larger than its predecessor, 14½ as compared with 10 million words, fifteen instead of ten volumes, but also, to quote the opening words of the brief editorial preface, "it is in fact an entirely new work, new in conception and plan as well as in execution". Nevertheless, the spirit and tradition of the older "Chambers's" still persists—it is as though a new, handsome, fashionably and well-clad, abundantly healthy and virile person has been created in which to present the revived spirit of the older "Chambers's" to the post-war world.

The traditional alphabetical arrangement has been retained, though others were considered. The various articles, some of considerable length, bear their author's initials, and an alphabetical key to the initials is provided for each volume. In addition, a complete alphabetical index of the names of all the contributors, with references to their major contributions, is included in Volume 15. This seemingly somewhat wasteful duplication could easily have been avoided by attaching the contributors' full names to separate articles. Volume 15 is a distinctly praiseworthy innovation and deserves special mention. The first half of the volume consists of a world atlas, and includes an exceptionally fine series of maps produced by the experienced firm of Bartholomew's, and a detailed index to the place names, etc., shown on the maps. The second half contains, in addition to the index of contributors, a classified list of articles and a general subject index. In the classified list, the various departments of knowledge are grouped into a number of broad classes, and then subdivided into sections; physics, for example, being divided into the following sections: general properties of matter, heat and thermodynamics, sound, light, electricity, magnetism, atomic physics and biographies. The last-named are listed according to countries of origin. It is doubtful whether this classified list will be much used by the ordinary user of the encyclopædia. The general index, on the other hand, is a valuable addition. "It pin-points, wherever it may be in the Encyclopædia, the particular item of information which the reader needs; and it gives a proper selection of references to passages which the enquirer with less-defined needs will find relevant to the topic he looks up."

The planning of each main section and the choice of the appropriate contributors were allotted to an appropriate advisory editor, though which to whom we are not told explicitly. From the list of contributors it would appear that, where possible, the editors have chosen mainly teachers of the highest rank who possess both considerable practical experience of their subjects and experience of imparting their knowledge to others. Thus, the subject-matter in the various articles is well presented and the fundamentals are clearly stressed. In fact, some of the longer articles, especially in the physical sciences, can be described only as model text-books, without that mass of detail which usually clutters up the average undergraduate text-book and which so often obscures the vital points. The shorter articles are equally clear, and both the line diagrams and photographs, in colour and in black-and-white, are numerous, well-chosen and elegantly produced. The biographical thumb-nail sketches of famous statesmen, historians, men of science, etc., are adequate, but give the impression of having been cut down to the bare minimum. Is not Prof. Albert Einstein worthy of more than two-thirds of a column, and must he still be listed as a German physicist?

With regard to the articles themselves, it is impossible for the present reviewer to do more than give a few brief impressions of those within the mathematical, chemical and physical sections. Some have been read with care and with great interest, and the reviewer has been more than satisfied. Others have been dipped into from curiosity and the reviewer has in many cases been fascinated by the contents. The standard is invariably high. There is some repetition and overlapping, but mainly for clarity and completeness. The mathematics in several cases, perhaps, becomes somewhat difficult and abstruse too rapidly; but then the initial standard of the reader must invariably remain unknown. Physics, which within the past few decades has expanded enormously, has been allotted almost twice the space it occupied in previous editions; but it still takes second place to religion and biology. Recent developments in the branches of applied physics are given due prominence. The importance of the growth of the science of instrumentation is adequately stressed and described by no less an authority than A. J. Philpot. Recent military applications, like radar, infra-red and other electronic devices, are well treated, though strangely enough 'electronics' or 'electronic engineering', which has been described as now the largest industry in the world, is a sad omission as a separate article from the encyclopædia. The fundamentals of electricity, electrical engineering, electrochemistry and the distribution of electricity cover some seventy pages, and the nationalization of electricity in 1947 is briefly discussed, though 'load-shedding' is not mentioned. The main articles on heat and thermodynamics and on light are good; those on spectroscopy by Dr. A. G. Gaydon and interferometry by Prof. S. Tolansky are remarkably clear and, to single out just one more out of so many similar articles, that on superconductivity by Dr E R Andrew is precise, restrained and well constructed

It is natural to turn to see what the encyclopædia has to say about the important and topical subject of 'nuclear energy', but here the physicist who is particular about nomenclature will be disappointed, for he is referred to the less correct 'atomic energy' First, the stable atom is discussed by Prof J R Partington and, as befits such an able and competent chemist and writer, the account is historically accurate and gives a concise summary of the structure of the atom Then follows a comprehensive statement of the different types of atomic disintegration apparatus (the absence of the usual photographs of various actual cyclotrons, etc, was noted) and finally an article on atomic energy by Dr J L Michiels, who is also the author of the article on radioactivity The atomic bomb gets scarcely a mention and the hydrogen bomb none at all It is stated that "Chambers's" policy is to be impartial on controversial matters, but it is a pity to have suppressed all the exciting details of the original atomic energy project in favour of sober hard facts about nuclear reactions and reactors There is no special section headed "atomic bomb", but is there perhaps a chance significance in the fact that the section on "atonement" follows immediately on that of "atomic energy"?

The articles on chemistry, chemical industries, chemical warfare, the individual chemical elements and compounds, and on chemical products such as plastics, fibres and synthetic materials of all kinds, are scholarly and packed with information Frequently they err on the technical side and assume the reader has more than a nodding acquaintance with symbolic chemistry However, there is always something to capture the reader's interest, and for the erudite scholar the short bibliographies, appended to the major articles, should prove valuable for further reading and study

Several minor errors, inconsistencies and omissions have been noted, for example, Dr Blackman's and Dr Hoare's definitions of specific heat cannot be reconciled, several physical quantities are stated with incorrect units, 'electrical capacity' is preferred to 'capacitance', the magnetic amplifier is nowhere mentioned, discussions in many cases obviously date to no later than 1942, whereas others give details of work so recent as late 1948, Weber is deprived of his initials, and the most surprising omission of all is that, with Dr B M Crowther, the editor of *Science Abstracts*, as one of the contributors, there should be no reference at all to scientific information and abstracting services This, it will be recalled, was the subject of a Royal Society conference in mid-1948 But these are trivialities, and even an encyclopædia of fifteen volumes cannot contain everything or be omniscient

It is to be hoped that this admittedly brief survey has given some indication of what is, in the opinion of the reviewer, an outstanding British achievement of intellect and craftsmanship "Chambers's Encyclopædia" is undoubtedly worth one of the highest places of merit among the display of British products at the coming Festival of Britain It should be consulted by both the scholar looking for detailed knowledge and by the ordinary earnest inquirer It is assured of success because it is good, for as the editor remarks, "success in this field is necessarily synonymous with good" S Weintroub

AMERICAN HANDBOOK OF INSECTICIDES

Chemistry and Uses of Insecticides

By Dr E R de Ong Pp viii+345 (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd, 1948) 36*s* net

THIS book is stated in the preface to be a guide to the established insecticides "and other biocides" for the benefit of the professional worker and college student It contains chapters on arsenic, copper, sulphur, oils, fumigants, plant derivatives and synthetic compounds Each chapter concludes with a long list of references, almost all to American literature

New insecticides, particularly the synthetic organic compounds, appear so frequently and progress so rapidly from the chemist's bench to the salesman's ornate container that the professional worker has difficulty in keeping up to date He will therefore welcome this guide to the pest control materials available up to 1948 The "Dictionary of Insecticides", a list of chemicals with brief notes on their uses, is a valuable addition The author has had considerable experience of practical entomology in the western part of the United States and writes of and for that area Many materials familiar to the British reader are omitted or barely mentioned Tar distillates, for example, which revolutionized European fruit-growing in the early 1920's, are discussed in eight lines They are said to have been "largely replaced by dinitro compounds", yet the use of dinitro-*o*-cresol in petroleum oil, the most usual European alternative, is not even mentioned Some of the uses of petroleum oils and sulphur in the very full chapters on these subjects will strike the British entomologist as most unsafe to the crop, and will illustrate the dangers of adopting without question spray methods devised for crops in widely different climatic conditions

The chapter headings are on the same lines as those used by Martin (1944) and Shepherd (1941), but the author's approach to the subject is much more from the point of view of the commercial user of insecticides There is less emphasis on the chemistry of the insecticides and no discussion of the relation of chemical structure to insecticidal activity On the other hand, more attention is given to subjects of equal importance in practice, such as sources of supply, compatibility of spray materials, phytotoxicity, labelling, packing and inter-State transport regulations There is also a list of official antidotes

The chapter on synthetic organic compounds is of the greatest interest at the moment and might perhaps have been extended with advantage Since the book appears to have been completed in 1947, the organic phosphorus compounds are barely mentioned and some of the recent chlorinated compounds are not included About one hundred organic compounds are listed and discussed briefly or at length, according to their importance This section constitutes a survey of the literature without comment by the author No attempt is made to assess the relative value for any specific purpose of the compounds listed The references given would enable the specialist to make this assessment for himself, but the university student would have difficulty in doing so

The illustrations are mainly of American commercial spraying machines, but they are not mentioned in the text There are a number of minor misprints, some unfortunately in the scientific names of insects and chemicals

The reactions of both insects and crops to chemical treatment are so much influenced by climate, crop-growing practices and varieties of crop grown that it would be almost impossible to write a book which should take account of all these factors The fact that this one is written for the western part of the United States does not in any way prevent its being of great value to professional workers in other countries

R M GREENSLADE

PROPERTIES OF GLASS AND PLASTICS

The Strength of Plastics and Glass

A Study in Time-Sensitive Materials By Dr R N. Haward Pp viii+245+16 plates (London · Cleaver-Hume Press, Ltd , New York Interscience Publishers, Inc , 1949) 30*s* net

Physical Properties of Glass

By J E Stanworth (Monographs on the Physics and Chemistry of Materials) Pp viii+224 (Oxford Clarendon Press , London Oxford University Press, 1950) 21*s* net

THESE two monographs reveal the remarkable difference which has developed in the progress of research on the strength or mechanical properties of glass, on one hand, and on viscous, electrical and mechanical properties, on the other

The study of glass and plastics as solids has yielded a vast amount of experimental results on the strength properties of these materials In the first book, Dr R N Haward has carefully filtered and separated the available information and produced a source of factual knowledge and a comprehensive summary of the present position in this important field of investigation It is clear, however, that theoretical work lags far behind the experimental results Dr Haward's book is therefore primarily one for reference to experimental techniques and results From this aspect it should be of value not only to all those interested in the strength properties of plastics or glass, but also to students of the mechanical properties of materials in general In addition to the reason advanced in the introductory chapter for linking glass and plastics, there might also have been added the combined use of these materials in laminated glass and their many notable similarities particularly at other than ordinary temperatures A lack of appreciation of transformation phenomena in glasses and, in fact, in all vitreous substances leads, for example, to a somewhat hesitant discussion of the dilatometric transition point of plastics

The equally excellent and noteworthy summary by J E Stanworth of research on those physical properties which have a bearing on present theories of the structure of inorganic glasses just as clearly demonstrates the lack of experimental work, particularly in the fields of viscosity, surface tension and magnetic properties Theoretical speculations have developed and progressed in a most stimulating manner after the first impetus given by the fundamental ideas of Zachariasen and the experimental deductions of Warren and his co-workers

A somewhat high proportion of Stanworth's monograph is also concerned with the strength of glass This duplication is unfortunate, and these chapters could well have been omitted without diminishing the value and interest of the rest of the volume, or perhaps replaced by some information on, say, infra-red spectra of glasses.

A defect common to both authors is the occurrence of instances where a more critical approach to theoretical speculations might have been taken A point of similarity for which, however, both authors are to be commended lies in the clear and well-written manner in which the subjects, admittedly difficult, have been presented

It is to be regretted that the rather high price of such important additions to the still somewhat meagre literature on the properties of glass may serve to keep them out of the possession of young technologists, on whom future progress in our knowledge and insight into the structure of glasses, and liquids in general, depends

H COLE

SCIENCE AND RELIGION

Science, History and Faith

By Canon Richardson Pp. vi+210 (London, New York and Toronto Oxford University Press, 1950) 6*s* 6*d* net , School edition, 5*s* net

THIS book is uniform with three others which are being published by the Oxford University Press under the title "A Primer of Christianity" and which deal respectively with the Beginning, the Furtherance and the Truth of the Gospel Canon Richardson has written especially for those who are conscious of the great importance to-day of the scientific outlook and want to know how Christian faith and Christian theology can claim to be true when measured by scientific standards The author will undoubtedly hold the audience he has in mind, and his own clarity of style carries with it a deep understanding of the problems involved The first chapter, "The Knowledge of God", is followed by "Science Religion and Philosophy", designed for those specially interested in science The second chapter is divided into parts dealing with the scientific method, the comparative study of science, and the science of theology The theme is well thought out and is a fair statement of the relation between science and theology The latter is introduced as "the scientific discipline which studies the phenomena presented by the existence of the Christian religion—its faith, worship, and life—in history and to-day" The layman is helped to the understanding of philosophy by the explanation of terms such as 'naturalism'

The author's handling of historical evidence is equally convincing, as is also his treatment of miracles Space is found for discussion of the doctrine of the Trinity, salvation and eschatology In a concluding section dealing with the preparatory character of this world, Canon Richardson makes a claim for education which is of special significance to-day · "education is the process by which minds are led to choose and cherish the truly valuable ends of life, not for the sake of profit or utility, or in order that the pupils may 'get on' in the world, but simply because they are the ends of life and valuable for their own sake . there is a difference between education and propaganda true education leads the pupil to seek and love value , propaganda deprives him of his freedom and tries to produce in him not a free choice but a mechanical reaction"

H D ANTHONY

THE ETHICS OF EXPERIMENTS ON ANIMALS

By Major C W HUME

IN considering this difficult subject, two principles may be taken for granted First, the relief of suffering in medical and veterinary practice depends on the sciences of physiology, pathology and pharmacology, which in turn depend upon experiments on animals , experimentation is, therefore, in this respect desirable Secondly, although many experiments involve little or no suffering, others do involve various degrees of it, and the infliction of suffering is *per se* undesirable There is thus a partial conflict between the two principles, and the problem of reconciling them when it is possible to do so, and of deciding what compromise ought to be made when reconciliation is not possible, is a difficult one which deserves dispassionate study

Current Practice

Great Britain is far ahead of every other country in the world in its handling of this difficult problem An admirable account of the British law and practice has been published by the Research Defence Society (1*s*), and further information will be found in my chapter in the "UFAW Handbook on the Care and Management of Laboratory Animals" The two main features of the British system are the licensing of experimenters, subject to specified conditions, and the function of the inspectors acting for the Home Secretary Although the inspectors have disciplinary powers in reserve, the effectiveness of their work depends essentially on the goodwill and co-operation of the licensees, and in any practicable system this must be so

In many other countries, unfortunately, the situation is far less satisfactory As regards laboratories in the Latin countries, eminent British physiologists have expressed to me the most emphatic condemnation of procedures they had seen in certain of them In the United States there is no effective law, but a code of humane conduct has been voluntarily drawn up by biologists, and many conform to it Others, unfortunately, do not It would be easy to cite instances , for example, one in which an excessively painful technique, applied by one group of humane research workers to domestic animals under full nembutal anæsthesia, was applied to rats in a state of full consciousness, without any justification whatever, by a different group of workers who, presumably, could not be bothered to maintain anæsthesia

On the average, biologists are probably more humane than laymen, since they are less likely to regard unpopular species with contempt But around every average there is a statistical scatter, and it is the workers represented by the lower tail of the distribution curve who make co-ordination desirable It is possible for intellectual brilliance to co-exist with want of sensibility

Reconciliation of Conflicting Principles

The problem is best studied in the light of British experience The two principles enunciated in my first paragraph may be said to be reconciled, wholly or in part, in so far as steps are taken to eliminate or reduce the amount of discomfort or suffering involved

The comfort of laboratory animals depends mainly on management and handling In recent years these subjects have received growing attention, which was accentuated by the publication of the "UFAW Handbook" , and the Medical Research Council has recently set up a Laboratory Animals Bureau to advise experimenters on it No doubt the technical value of hygiene is the main reason given overtly for these precautions, but we may be sure that a humanitarian motive also underlies them At all events, the need for good animal-management and for large and well-appointed animal houses in which it can be carried out is generally recognized by men of science, although the lay boards of management of some hospitals and institutes could advantageously try harder than they do to make funds available for such purposes

Still more does the comfort of laboratory animals depend on the laboratory technicians who handle them The status and prospects of members of this profession need, therefore, to be such as to attract plenty of entrants of the right type Recently an important step forward has been taken in the formation of the Animal Technicians' Association under the auspices of the Laboratory Animals Bureau Another encouraging development has been the institution of a course for laboratory technicians (including animal technicians) at the Paddington Technical Institute, with a particularly broad-minded outlook and a specific regard for humanitarian considerations

Veterinary surgeons could give more help than they are usually invited to give in advising on the handling of laboratory animals British laboratories might do worse than follow the lead of those in Amsterdam, which have appointed a qualified veterinary surgeon to be their honorary veterinary adviser

Biological assay not infrequently uses the *LD*50 determination, which involves various degrees of discomfort or suffering Although it is recognized that non-biological criteria, when available, give greater precision, the supposition that a biological criterion is more relevant to therapeutic potency appears sometimes to count on the other side when the choice has to be made But the lethal dose and the therapeutic dose belong to parts of the dose-response characteristic which are remote from one another, and one would like to be sure that full account is always taken of the degree of irrelevance introduced by the extrapolation which results from this fact In any event, the humane motive supplies an additional reason for searching for chemical and physical criteria

The design of experiments, too, has a humanitarian aspect Economy in sampling becomes particularly important in any research which may involve discomfort or suffering Methodologically a pure research may conveniently be thought of as comprising three stages first, the formulation of an explanatory hypothesis on the basis of previous knowledge , secondly, the deduction from the explanatory hypothesis of a descriptive hypothesis comprising a posited relation between observables , and thirdly, the testing of the descriptive hypothesis by experiment, so as to verify or refute the explanatory hypothesis which implies it In this verification process a systematic economy in sampling has been made possible by the methods introduced by R A Fisher and his school But the humanitarian aspect of the first two stages mentioned above deserves an equally systematic study A particular case with important general implications has been considered in the *British Journal of Radiology* (22, 671 , 1949) by Dr John Read, who suggests that lethal radiation experiments "are not legitimate if planned (*a*) to see what effects will turn up, (*b*) to settle some relatively trivial point, or one that is virtually self-evident, or (*c*) to add fragmentary pieces of unco-ordinated data" Nor yet (*d*) to rediscover something which is already known and recorded in the literature for anybody who will take the trouble to look , nor (*e*) if the probability of obtaining fruitful results is not high He illustrates these points by reference to determinations of the lethal dose of whole-body radiation, involving mortal illness if not pain, which confound a number of independent factors that a sound scientific method would distinguish But the whole of Dr Read's paper deserves careful study by anybody interested in scientific method, and not only by radiologists

Restrictions on Research

There remains the question When a proposed research cannot be carried out without the imposition of discomfort or suffering, at what level does it cease to be admissible ? What compromise ought to be made between the claims of science and those of laboratory animals when the two cannot be reconciled ? Analogy with the commercial treatment of animals is not a satisfactory guide, for barbarous customs still survive A scientific worker would not wish to take an illiterate trapper as his exemplar, nor conform his ethics to customs which thinking men desire to abolish In practice the problem has been approached in Britain by absolute restriction in some cases and by relative restriction in others

Absolute Restrictions

Before 1912 it was assumed that science had an absolute right of way, and that unlimited pain might properly be inflicted if a given piece of information could not be got without it The Royal Commission which reported in 1912, however, made a contrary recommendation and this, in principle at least, has been adopted by the Home Office, conformably to the fact that the validity of the utilitarian principle is not unlimited

Two absolute rules are made by the Home Office, and regarded as binding The first is in effect that all cutting operations must be performed under full anæsthesia The second is the pain rule which has been attached to every licence since the report of the second Royal Commission, and prescribes, *inter alia*, that if an animal is found to be suffering severe pain which is likely to endure it must forthwith be painlessly killed This rule is obviously difficult to interpret, but it establishes an invaluable principle, and not the least harmful of the anti-vivisectionists' errors has been their eagerness to make capital out of its difficulties A partial solution of these will be suggested later , meanwhile their nature must be noted The licensee is responsible for deciding what is severe pain, and what period of time is denoted by "likely to endure", and this he must at present do without any standards of comparison to guide him At least two acquaintances of mine have assayed red squill, much as they disliked doing it The fact that this extremely cruel poison is used extensively in commercial deratization is beside the point , the point is that the work was done under a licence conditioned by the pain rule, and that it consequently illustrates the need for standardizing that rule, to which I shall recur

Relative Restrictions

When a licence is sought for an experiment which involves discomfort or suffering short of that prohibited by the absolute restrictions, three considerations are relevant First, there is the assessment of its prospective scientific value, which grows increasingly difficult with increasing specialization For this and other reasons the scientific qualifications of applicants for licences are important, and it is generally agreed that these are gone into by the inspectors with really great care Since five inspectors have to deal with 3,445 licensees in 466 places, a heavy responsibility rests on the sponsor who recommends an applicant , but licences are certainly not granted without conscientious discrimination

The second consideration is one which at present is not officially recognized It arises out of the fact, already noticed, that no system of control can be effective without the goodwill of the licensees themselves If, therefore, a licensee is not a strictly humane person, the system will fail in respect of him, but no inquiry is at present made into the moral character of applicants for licences A relevant fact is that while it is easy to discipline a licensee who has inadvertently made some formal slip, such as furnishing certificate *E* when he ought to have furnished *EE*, it is much more difficult to check a man who has carelessly allowed a rat to recover prematurely from an anæsthetic Of course, most licensees *happen* to be humane , but it does not seem right that while a candidate for the Civil Service has to show an appropriate moral record, the humaneness of a licensee should be left to chance

There remains this third and very difficult consideration What amount of discomfort or suffering is admissible in any given case, regard being had to the importance of the results expected from the experiment in view ? We have noticed a similar difficulty already in the case of the pain rule At present the Home Office refers any new and dubious procedure to the Advisory Committee, and in this way a body of precedents is built up, much as common law and case law are built up from the decisions of judges But there is this difference, that common law and case law are open to discussion in the legal Press and by the Bar They are subject to the healthy influence of expert public opinion But, unlike the judiciary, the Home Office is in the position of a benevolent Star Chamber overwhelmed with business The only solution hitherto proposed is that experimental procedures should be classified into a small number of grades according to their severity, and licences be correspondingly graded and granted with appropriately graded discrimination The grades could not be rigorously defined by genus and differentia The method of indicating them would have to be that adopted in the British law on charities that is to say, for each grade there would have to be a certain number of type procedures or precedents, other procedures being classified by analogy with them. The precedents would, of course, be open to continuous review in the light of humane scientific opinion This proposal has aroused some keen hostility, but with the lapse of time further consideration may perhaps show it to be a logical development of the existing practice, one which might in Great Britain be adopted by administrative action and in foreign countries be embodied in that legislation which is long overdue in almost all of them

Need for Discussion

The question where the line ought to be drawn between the claims of science and those of laboratory animals is an excessively difficult one about which normal decent people disagree The only means for arriving at an ideally just solution is frank discussion among humane men of science But here a real difficulty arises Anything which may be said in such a discussion is liable to be seized upon, torn from its context, misunderstood and distorted by controversialists who will make an unscrupulous use of it for their own purposes This fact, and the resentment felt by men of science at the calumnies to which they have been subjected, are obstacles to frank discussion, but they are obstacles which must be over ridden because obscurantism is an intolerable evil Moreover, anti-vivisectionist attacks on science are greatly helped by the suspicion that men of science cannot care much about avoiding cruelty since so few of them ever mention the subject except in self-defence

At all events, here are excessively difficult ethical problems that deserve an increasingly complete solution, and in view of their technical character nobody except humane men of science can solve them

ANIMAL AND VEGETABLE FOODS

ON January 20, the Nutrition Society held a symposium at the London School of Hygiene and Tropical Medicine on "The Comparative Merits of Animal and Vegetable Foods in Nutrition" Prof R C Garry, in the chair, introduced the subject by referring to the tradition held abroad that the British are great meat eaters Economic conditions, he said, are forcing us to reduce our consumption of meat, and a careful examination is needed to consider the nutritional effects of such a change in our food habits

The need for a source of protein in the diet has been understood for a hundred years At the turn of the century, German workers demonstrated that individual proteins differed in their nutritive value, and advocated the use of diets high in protein, and with a large proportion coming from animal foods More recent work has caused some modification of this view

Dr G R Tristram read an introductory paper on "The Biochemistry of Animal and Vegetable Proteins" in which he said that there is no difference clearly separating the biochemical properties of the pure proteins so far isolated and examined However, many of the proteins obtained from seeds are partially deficient in one or more of the essential amino-acids The protein preparations so far obtained from leaves have a more balanced composition In a normal foodstuff the aggregate of proteins tends to be better balanced in composition than individual members The non-protein nitrogen fraction of the food may also be of importance Choline is known to have a methionine-sparing action, and methionine itself has been found to occur free in some plant tissues

Dr K J Carpenter then spoke on "Relative Nutritional Values of Animal and Vegetable Proteins for Animals" For the rat, the animal feeding stuffs are generally higher in biological value than are the vegetable materials The experiments used for these determinations are not invalidated by the discovery of the 'animal protein factors', and the differences are explicable in terms of amino-acid composition For cattle and sheep the proteins of the common feeding-stuffs are approximately equal in biological value, regardless of their amino-acid composition This may be explained by the synthetic powers of the alimentary micro-flora in ruminants The practical question for pigs and poultry, continued Dr Carpenter, is to determine the relative value of different proteins as supplements to a cereal mixture For this purpose fish meal and milk products are superior to the oil meals, although soya-bean meal is of exceptional value Recent work at the Rowett Research Institute has indicated that grass proteins are also of lower value than had been predicted from their amino-acid analyses In some cases the partial deficiencies of the vegetable materials can be compensated by feeding them at a higher level

The "Conversion Factors of Vegetable and Animal Food for Human Consumption" were discussed by Dr K L Blaxter, who said that Prof W C Rose has recently determined the human requirements for the individual essential amino-acids It is therefore possible to calculate the production, from an acre of land under various crops, of the vitamins and amino-acids, calculated in terms of man-year requirements The vegetable crops satisfy greater requirements if used directly for feeding than if used indirectly for meat and milk production Nevertheless, the provision of requirements by the cereals is unbalanced and lacking in vitamins and protein relative to the provision of calories In the example of wheat and sugar-beet production, the nutritional value of the crop in terms of 75 per cent extraction flour and refined sugar is significantly supplemented, especially in protein, by the milk production that can be obtained from feeding the by-products—millers' offals and sugar beet tops—without the use of more land Animal and vegetable foods are therefore to some extent complementary rather than alternatives

Dr D A Boyd then discussed the efficiency with which different classes of stock convert vegetable into animal products The efficiency of energy conversion is approximately 19 per cent for bacon and milk production, and only 7–10 per cent for beef, mutton and egg production A national balance-sheet of food production and imports shows that, of 21 7 million tons of starch-equivalent fed annually to animals in Great Britain, only 1 9 million tons starch-equivalent is obtained in animal products This is an overall yield of about 1 11, whereas a ratio of 1 6 would be expected This suggests scope for increasing efficiency The man-hours of labour needed for the production of 1 cwt of starch-equivalent from animal foods are also considerably in excess of those needed for cereal production On this basis, wheat is the crop produced with least labour

To introduce the afternoon session, Dame Harriette Chick spoke of the work done at the Lister Institute on the improvement of vegetable proteins by admixture In some cases there is important supplementation within a single foodstuff For example, a mixture of wheat bran and white flour is of greater value for the rat than when each is fed separately The non-protein nitrogen in potato juice is also of supplementary value to the purified preparations of potato 'tuberin' This cannot be explained by the amino-acid content of the juice In these trials with vegetable proteins young rats attained a reasonable growth-rate, but were not able to rear a second generation In the light of recent American work, this may be explained by the rats having carried a reserve of vitamin B_{12} from their suckling period sufficient for the next few weeks, but not sufficient for a whole life-cycle For short-term growth, a mixture of soya flour 56 per cent, malt extract of barley 34 per cent and white flour 10 per cent is, on an equal nitrogen basis, equal to whole milk for rats

Dr Lucy Mills continued with an account of the results she has obtained in the treatment of 'malignant malnutrition' or 'kwashiorkor' among Zulu children The condition appears to be identical with the 'fatty liver disease' in the West Indies After the babies have been weaned from the breast, they receive no cow's milk, or even grubs and locusts as in some primitive societies, and are fed only on porridges made from cereals with occasional green vegetables They appear to be healthy until the sudden onset of diarrhœa and an œdema, accompanied by low levels of serum albumen The œdema then usually clears up and the condition enters an atrophic stage The mortality-rate for children taken to hospital at this stage and put on a normal diet has been in the region of 50 per cent Post-mortem examination shows a consistent mild normochromic anæmia and an enlarged liver with fatty infiltration The only treatment so far tested which is really effective is to force-feed the curds from skimmed milk, with nothing else, for several days There is some evidence that this condition is caused specifically by a deficiency of animal protein It occurs even when calorie intake is normal Dr A P. Meiklejohn, in the discussion, emphasized the widespread occurrence of this condition and the importance of further research into methods for its treatment and prevention

A paper on "The Nutritional Adequacy of a Vegetable Substitute for Milk" was then read by Dr R F. A Dean Of all the constituents of milk the protein fraction is, he said, the most difficult to replace from vegetable sources Some recent trials have been carried out with children in a home in Germany Over a sixteen-week period a control group received a diet of butter, potatoes, bread and milk cooked into semolina pudding Other groups received the same diet with the milk replaced by a soya–barley–wheat mixture The vegetable mixture, relative to milk, was still slightly deficient in some of the amino-acids , but, when it was fed so that 13 per cent of the calories came from proteins, growth was as good as with the milk ration in which only 11 per cent of the calories came from proteins Slight changes in the method of cooking the soya flour were, however, liable to produce digestive troubles When young rats were fed on the vegetable mixture they stopped growing after twelve weeks This was corrected by the addition of vitamin B_{12} to the diet The children might have shown a similar deficiency if fed on the all-vegetable diet for longer periods

In the general discussion which followed, it was agreed that there can be no hard-and-fast rule as to the minimum human requirements for animal (including milk) proteins Experiments suggest that with a very careful choice of supplementary proteins and with vitamin-rich foods, an adequate all-vegetable diet can be constructed Nevertheless, in the practical world there appear to be sound reasons for the scientific approval of mankind's enjoyment of animal foods, whether they take the form of roast beef, cheese or merely caterpillars

K J CARPENTER

RECENT THEORIES OF TRANSPORT PROCESSES IN LIQUIDS

By Dr R. EISENSCHITZ

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THE properties of matter in thermal equilibrium can be derived from general principles which are very closely related to the laws of thermodynamics[1] and have a similarly wide range of validity There is, however, no corresponding general theory determining those properties of matter which are associated with the rate of an irreversible process, such as viscous flow or thermal conduction This lack of general principles is particularly unsatisfactory with regard to the properties of liquids There are a number of successful kinetic explanations of some of the properties of the liquid state[2,12], but they are usually not capable of generalization.

In the past four years a new start has been made with the kinetic theory of liquids with the object of substituting methods based on the fundamental principles of dynamics for the arbitrary hypotheses which have often been invoked In this article the problems, methods and achievements of the recent theoretical work are reviewed with particular reference to the explanation of irreversible processes

Flow of Momentum and Energy

In the kinetic theory of gases, the flow of momentum or energy which is observed in measuring the viscosity or thermal conductivity of a gas is considered to be due to the momentum or energy which a molecule carries with itself when moving through empty space between collisions Every molecule is supposed to contribute the product of its momentum and its velocity in the case of viscous flow, and the product of its kinetic energy and its velocity in the case of thermal conduction

It has been felt for some time[4] that, in liquids, momentum and energy should be considered as transmitted by the action of intermolecular forces rather than by the movement of molecules The mechanism of transmission has been fully recognized in the case of dense gases (ref 5, chap 16), crystals[6], solutions of electrolytes[7] and finally of liquids

If momentum and energy are transmitted by the intermolecular forces, it is no longer possible to speak of contributions of single molecules but only of pairs of molecules Every pair contributes to the flow of momentum the product of the intermolecular distance times the intermolecular force, so that the rate at which oriented momentum is added to one molecule is the same as the rate at which it is withdrawn from the other With regard to the transmission of energy, we can assume that one of the molecules of the pair is at rest, since on the average it is, in fact, at rest Then the pair contributes to the flow of energy, first, a term which is equal to the product of the potential energy of interaction and the velocity of the molecule which is considered free to move, and, secondly, a term equal to the distance of the two molecules multiplied by the rate at which the kinetic energy of the relative movement increases in response to the intermolecular forces It may be added that the flow of energy is a vector and the flow of momentum is a tensor, so that they have three and six components respectively

These arguments are sufficient for explaining the meaning of expressions obtained by Born and Green (ref 8, sec 4) and later by Irving and Kirkwood[9] The formulæ quoted here are derived from general expressions given by Kirkwood Let, u, v, w be the components of velocity of a molecule, m its mass, x, y, z, r the relative co-ordinates and the distance of the molecules in a pair, and $\Phi(r)$ the potential of mutual interaction so that $-d\Phi(r)/dr$ is the resultant central attractive or repulsive force The number of molecules in the unit of volume is N/V and the number of pairs in the unit of volume is $N^2/2V$ The statistical mean (expectation) is denoted by a bar (It may be recalled that, in general, the mean value of a product differs from the product of the mean factors)

With this notation, a component of the flow of momentum is obtained as

$$P_{xy} = m(N/V)\,(\overline{uv}) - (N^2/2V)\,\overline{[(d\Phi/dr)(xy/r)]} \quad (1)$$

and a component of the flow of energy as

$$Q_x = m(N/2V)\,\overline{[u(u^2+v^2+w^2)]} + (N^2/2V)\,\{(\overline{\Phi u}) - \overline{[(d\Phi/dr)(x/r)(xu+yv+zw)]}\}. \quad (2)$$

In both expressions the second term is negligible for gases, and the first term is negligible for liquids

These formulæ can be evaluated only if the probability distribution is known from which the mean value is to be derived Although in viscous flow and thermal conduction deviations from equilibrium are small, the equilibrium distribution cannot be used because the resulting mean values would vanish

Hypothesis of Molecular Chaos

The change of velocity of a gas molecule in a collision is derived from the laws of mechanics The succession of collisions is, however, considered to be a matter of probability It is accordingly implied that the velocities before and after a small number of collisions are statistically independent, so that the probability for a final velocity does not depend on the initial velocity This is implicitly postulated in terms of the hypothesis of molecular chaos (ref 5, chap 3), which seems to be necessary for the kinetic explanation of irreversible processes

A similar assumption is required for liquids, where the molecules are always in a field of force originating from their neighbours and there are no collisions Kirkwood (ref 10, sec 2) formulated an appropriate hypothesis from which he derived important consequences He assumes that the forces acting on a molecule at different times are statistically independent provided that the time interval is not too small

This assumption is given a mathematical formulation corresponding to the practice of statisticians It is postulated that the correlation coefficient between the forces at different times should vanish or, in other words, that the mean value of the product of these forces should be zero

Let $X_1(t)$ be the x-component of the force which is exercised on the molecule 1 by the other molecules (labelled 2, 3 N) at the time t It depends, apart from the time, on the initial positions and velocities of all molecules According to Kirkwood's hypothesis,

$$\xi(t,t') = \overline{[X_1(t)\,X_1(t')]} = 0 \text{ for } |t-t'| > \tau, \quad (3)$$

where the mean value is taken over the positions and velocities of the molecules 2 N and where the magnitude of τ, the lower limit for the time interval, is discussed later

The time integral of the correlation coefficient, that is,

$$\int_0^t \xi(t,t')dt',$$

approaches accordingly a 'plateau value' Ξ which is independent of the time We assume that Ξ is a constant, possibly depending on the temperature

The increment of the velocity during the time t is equal to

$$\Delta u_1 = (1/m)\int_0^t X_1(t')dt' \quad (4)$$

The mean value of the square of the increment is accordingly

$$\overline{(\Delta u_1{}^2)} = (1/m^2)\int d\omega F_0\;\Big[\int_0^t X_1(t')\,dt'\Big]^2$$
$$= (2/m^2)\int_0^t dt'\int_0^{t'} \overline{\xi(t',t'')}dt'',$$

where F_0 is the probability distribution for all initial co-ordinates and velocities in thermal equilibrium, and $d\omega$ is the product of the differentials of the co-ordinates and velocities of the molecules 2, 3 N It follows that

$$(\overline{\Delta u_1{}^2}) = 2\,\Xi\,t/m^2, \quad (5)$$

so that the mean square increment is proportional to the time The significance of this result is considered in the later section of this article dealing with probability distribution

The Frictional Force

A molecule in a liquid is subject to frictional forces which arise in spite of the fact that the forces of molecular interaction are conservative

Let F be the distribution function for the co-ordinates and velocities of the molecules of a liquid at the time t in thermal equilibrium We express F in terms of the velocities at initial time ($t = 0$) on the assumption that the changes of the co-ordinates during the time interval t may be neglected

The velocities enter into the equilibrium distribution F by means of the expression

$$\exp\Big\{-(m/2kT)\sum_{j=1}^{N}(u_j{}^2+v_j{}^2+w_j{}^2)\Big\},$$

in which every factor can be expanded

$$\exp(-mu_j{}^2/2kT) = \exp(-mu_{j0}{}^2/2kT)\,[1 - mu_{j0}\Delta u_j/kT + \dots],$$

so that

$$F = F_0\,[1 - (m/kT)\sum_{j=1}^{N}(u_{j0}\Delta u_j + v_{j0}\Delta v_j + w_{j0}\Delta w_j) + \dots] \quad (6)$$

The mean value of Δu_1 vanishes if it is derived from the distribution function F_0 by integrating with respect to $d\omega$. If it is derived from the distribution function F, a term in the expansion (6) gives a non-vanishing contribution although the sum itself may vanish. Using equations (3) and (4), it follows that

$$\overline{\Delta u_1} = -(u_{10}/mkT)\int_0^t dt' \int_0^{t'} \xi(t',t'')dt'',$$

and this is, by Kirkwood's hypothesis,

$$\overline{\Delta u_1} = -u_{10}\,\Xi\,t/mkT. \qquad (7)$$

Defining a friction constant

$$\beta = m\,\Xi\,/kT \text{ (measured in sec}^{-1}\text{)},$$

it is seen that $\overline{\Delta u_1}/t = -\beta u_{10}$ is of the same form as if the molecule were a solid particle in a liquid on which a frictional force acts according to Stokes's law. The force does not cause any irreversible heating, since the liquid as a whole is a conservative system. If the liquid is in motion, then u_{10} in eq. (6) is replaced by $u_{10}-u^*$, where u^* is the x-component of the velocity of the liquid.

Similar arguments apply to the movement of a pair of molecules. It does not matter whether the movement is specified in terms of the velocities of the two molecules or in terms of the velocity of the centre of gravity and the relative velocity. Ξ is now to be derived from the total force on a molecule minus the force of interaction of the pair. There are two friction constants, β' for the movement of the centre of gravity and γ for the relative movement.

Whereas the movement of a gas molecule between collisions is readily derived by elementary methods, it is an involved problem to derive Ξ from the movement of a molecule in a liquid. For a first orientation the movement of a molecule may be regarded as a series of almost periodic oscillations about an average position which are interrupted if the molecule occasionally crosses the potential barrier produced by its neighbours. During the oscillations the correlation coefficient of the force fluctuates and vanishes only if the barrier is crossed. The time τ is accordingly much larger than a period of oscillation and is likely to be proportional to $\exp(U/kT)$, where U is the height of the potential barrier. The friction constant β should then be proportional to the same exponential factor.

The friction constant γ will in general differ from β. After deducing from the total force the contribution of a near neighbour, the remaining force is small and has little effect on the actual movement of the molecule. Its correlation coefficient is bound to vanish after a short time—possibly one period of oscillation. γ can also not vary very much with the temperature. The last conclusion agrees with a tentative calculation by Kirkwood (ref. 10, sec. 4). According to a later paper (ref. 9, eq. 20), Kirkwood seems, however, to ignore the difference between β and γ.

The Probability Distribution

According to the theory of the Brownian movement[11], the mean increment and mean square increment of the velocity u of a particle are proportional to the time and equal to $\overline{\Delta u} = -\beta(u-u^*)t$ and $\overline{(\Delta u^2)} = 2\beta kTt/m$, respectively, provided that t is not very small, or very large as compared with $1/\beta$. The mean higher powers of Δu are negligible.

According to equations (4) and (6), the mean increment and the mean square increment of velocity are proportional to the time, and their ratio is equal to $-m(u_{10}-u^*)/2kT$, it is easy to show that the mean values of the higher powers of Δu_1 are negligibly small. It may accordingly be expected, and can be conclusively demonstrated, that on account of Kirkwood's hypothesis, eq. (3), the theory of the Brownian movement applies to single molecules and pairs of molecules in a liquid (ref. 10, sec. 2). This theory provides the means for deriving those probability distributions which are necessary for calculating the flow of momentum and energy by evaluating eq. (1) and (2).

The correct probability distribution for the velocities and co-ordinates of one or two Brownian particles is determined by a partial differential equation (ref. 11, eq. 249). The solution of this equation is, however, a cumbersome problem. The distribution function for the co-ordinates only is approximately determined by a simpler partial differential equation (ref. 11, eq. 312), the equation of Smoluchowski, which is a good approximation if the frictional forces are large enough.

Assuming that the relative co-ordinates of a pair of molecules are statistically independent of the co-ordinates of the centre of gravity, Smoluchowski's equation for the relative co-ordinates reads

$$\partial g/\partial t = \mathrm{div}[\{(\mathrm{grad}\Phi^*/\gamma m) - \mathbf{c}^*\}g + \mathrm{grad}(gkT/\gamma m)], \quad (9)$$

where $g(x,y,z,t)$ is the probability distribution for the relative co-ordinates and $\mathbf{c}^*$ is the velocity vector of the liquid. The expression in the bracket on the right-hand side is the mean velocity per unit of volume or the density of flow. Φ^* is the mean potential of interaction between the molecules of a pair. In thermal equilibrium,

$$g = g_0 = (1/V)\exp(-\Phi^*/kT), \qquad (10)$$

which is obviously a solution of (9). g_0 determines the probability for finding a molecule at the distance r from another molecule which may occupy an arbitrary position; this probability can be obtained empirically from the X-ray interference pattern of the liquid[3,17]. If the distribution function is known, then the mean potential is defined by (10). In the following discussion the mean potential is assumed to be known as a function of the distance.

In the theory of viscous flow or thermal conduction, $\mathbf{c}^*$ or T is considered as varying with the co-ordinates. In order to find the probability distribution corresponding to steady viscous flow or steady flow of heat, the left-hand side of (9) is assumed to vanish and the resulting equation is solved by successive approximations. A correction term to the equilibrium distribution, which is proportional to the gradient of the (macroscopic) velocity or temperature, is found by neglecting the terms which are proportional to the square of the gradients.

This method was previously applied to the viscosity of dilute electrolytes[7] and was applied by me to liquids[13]. It is found that a flowing liquid is anisotropic even if it is monatomic. Eq. (9) is reduced to an ordinary differential equation with r as independent variable; the problems of viscous flow and thermal conduction lead to almost the same equation. Two boundary conditions are required for integration, of which only one is a direct consequence of the physical conditions. The other has to be chosen in such a way that irregularities of the solution are avoided if possible.

In viscous flow it was postulated that the deviation from the equilibrium distribution vanishes at large distances with a lower power of the distance than -3 in order to prevent the anisotropy from becoming infinite with infinitely increasing volume In the problem of thermal conduction the boundary condition prevents the local heat flow from becoming infinite if the distance between the molecules is small The two problems admit a consistent solution only if certain special (and somewhat artificial) assumptions are made with regard to the mean potential These assumptions are presumably not necessary if the correct theory of the Brownian movement is applied

Later, Kirkwood, Buff and Green[14] dealt with the problem of viscous flow These authors started their argument on the basis of the correct theory of the Brownian movement but continued the calculation by means of eq (9) This equation was integrated under boundary conditions different from those discussed in the preceding paragraph These authors considered also the case that **c*** corresponds to a uniform expansion and obtained an expression for the volume viscosity

Viscosity, Thermal Conductivity and Diffusion

The flow of momentum depends according to eq (1) only on the relative co-ordinates of a pair of molecules, so that the probability distribution in these co-ordinates is sufficient for evaluating (1) The flow of energy is proportional to the velocity, expression (2) can nevertheless be evaluated by means of the distribution function for the co-ordinates[15], the velocity is proportional to the flow, which can be expressed in terms of co-ordinates by means of the right-hand side of eq (9) The gradients of velocity or temperature enter as constant factors of the distribution function into the right-hand side of (1) and (2), by omitting these factors, expressions for the coefficients of viscosity and thermal conductivity are obtained

In this way the transport coefficients were calculated[13], the result depends upon the friction constant γ Assuming that this constant is not very sensitive towards changes of the temperature, the results are sufficient for comparing the effect of temperature on the coefficients of viscosity and thermal conductivity As a consequence of the different boundary conditions which are appropriate to the two problems, the coefficient of viscosity has a factor of the magnitude $\exp(U/kT)$, whereas there is no factor of this kind in the coefficient of thermal conductivity This is in good agreement with experimental facts and explains the widely different reaction of the two transport coefficients to changes of temperature, which is in striking contrast to the case of a gas The product of viscosity and thermal conductivity is independent of the friction constant and can be completely derived from equilibrium data The coefficient of self-diffusion, which is equal to $D = kT/2\beta$, may be expected to be proportional to $\exp(-U/kT)$ if the argument of the section of this article on the frictional force is accepted

Kirkwood, Buff and Green[14] obtained a numerical value for the viscosity of liquid argon at 89° K and found the right magnitude, the good agreement with experiment is particularly remarkable because the result is proportional to the friction constant, the derivation of which is so far the weakest link in the chain of deductions.

Born and Green, whose rigorous theory is reviewed in the following section, derived an expression for the value of the coefficient of viscosity (ref 8, sec 5) which applies if the radial distribution function does not differ appreciably from the distribution prevailing in thermal equilibrium They obtain the exponential temperature factor It would be of great interest to compare their result with the corresponding expression for the thermal conductivity in order to assess the significance of the distortions of the equilibrium distribution

Foundations for a Deductive Theory

From the theory reviewed in the preceding sections, it should be possible to obtain early results suitable for an experimental test It is, however, not fully satisfactory because the arguments are somewhat unconnected and depend on haphazard appeals to empirical facts Kinetic theory aims at establishing an unbroken sequence of deductions from the mechanics of molecules to the numerical values of the transport coefficients Born and Green were the first to face this problem[8,16,17,18] and to suggest a method of solution. Some of their arguments have also been followed up by Kirkwood[9,10,19]

The theory of irreversible processes should, as a matter of principle, be capable of deduction from Liouville's theorem, which is a direct consequence of the principles of Newtonian mechanics It is expressed in terms of a partial differential equation

$$\partial f^{(N)}/\partial t = \sum_{j=1}^{N} \sum_{x,y,z} [(u_j \partial f^{(N)}/\partial x_j) + (X_j \partial f^{(N)}/\partial u_j)], \quad (11)$$

where $f^{(N)}$ denotes the probability distribution for simultaneous values of the co-ordinates and velocities of all molecules Owing to the large number of independent variables, it has so far not been possible to select a particular solution of eq (11) which has any significance for transport processes.

This difficulty may be overcome by considering distribution functions for a smaller number of variables, such as apply to the co-ordinates of a single molecule, a pair, triplet, etc Let these distribution functions be denoted by $f^{(1)}, f^{(2)} \quad f^{(n)}$ respectively, these functions convey less information than the distribution function $f^{(N)}$ from which they can be derived by averaging

The set of distribution functions $f^{(n)}$ satisfies a number of integro-differential equations which are derived from (11) by integrations In every equation two unknown functions make their appearance, in the first $f^{(1)}$ and $f^{(2)}$, in the second $f^{(2)}$ and $f^{(3)}$, etc It is plausible to assume that the knowledge of a very small number of these distribution functions is sufficient for obtaining good approximations to all of them (ref 16, sec 4 and 6)

Born and Green claim that the probability distributions which are of significance for irreversible processes can be found by solving the set of integro-differential equations according to a scheme of successive approximations (ref 8, sec 3) The partial knowledge of the distribution function $f^{(1)}$ is used for determining $f^{(2)}$ uniquely, and this procedure is extended to the higher distribution functions No additional assumptions or subsidiary calculations are required, and the problems of the kinetic theory are reduced to a matter of computation It has not yet been demonstrated that this method is capable of predicting experimental results, the only calculations that have so far been published are not conclusive If this method is successful, an important step towards a general theory of irreversible processes is established

In conclusion, I wish to acknowledge that part of the arguments of the sections on the hypothesis of molecular chaos and on the frictional force are taken from unpublished work of Mr G H Cole

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OBITUARIES

Sir Leonard Gregory Parsons, F R S

Sir Leonard Parsons, emeritus professor of child health and dean of the Faculty of Medicine in the University of Birmingham, died suddenly on December 17 at the age of seventy-one years

Although practising as a general physician, Sir Leonard's main interest was with sick children It was his view that there was greater scope for research on children's diseases than on those of any other period of life, for disease in childhood could be studied "in its frankest and least complicated forms" He was responsible for the growth and reputation of the Birmingham Children's Hospital—a fact recognized in naming the specially designed infants' block the "Leonard Parsons Block"—and for establishing the University Department of Pædiatrics He was quick to appreciate the value of biochemistry, and with infinite patience and perseverance built up a research department which has attracted pædiatricians from many schools, and from which young physicians, trained and inspired by him, have gone out to different parts of the world Appreciation of his academic work has been shown in the many honours that fell to him and in the many invitations to lecture which came to him from learned societies at home, in the United States and in Canada—from the Arris and Gale Lecture in 1912 to the Harben Lectures which he delivered just a few days before his death His early effort was concerned with nutritional disorders of infants, and the results were embodied in the Goulstonian Lectures (1923) These showed that many of the 'wasting diseases of infancy' are the result of 'qualitative starvation' Later work clarified clinical problems in vitamin deficiencies, and his studies of fat metabolism in cœliac disease were recorded in the Rachford Memorial Lecture given at the University of Cincinnati in 1932 What may prove to have been his most important work was a large-scale investigation, undertaken between 1930 and 1940, into the anæmias of infancy and childhood His contributions to the study of hæmolytic anæmia were especially valuable and linked up with the discovery of the *Rh* factor To the group of diseases related to this, he gave the now generally accepted name of "the hæmolytic disease of the new-born", which, with other ante-natal factors prejudicial to the infant, were impressively reviewed in his Blair Bell Lecture (1945) In giving it the title of "Ante-Natal Pædiatrics" he left no doubt of his conviction of the need for full co-operation between the work of the obstetrician and that of the pædiatrician

Sir Leonard Parsons was a graduate of the University of Birmingham , but, as was customary in the days when he was a medical student, took his medical degree as an external student of the University of London He first became a member of the Board of the Faculty of Medicine of the University of Birmingham in 1915 and was made professor of pædiatrics in 1929 Sir Leonard succeeded Dr Stanley Barnes as dean of the Faculty of Medicine in 1941 and it fell to his lot to steer the Medical School of the University through the difficult period of expansion which took place after 1945 The successful way in which the Faculty of Medicine has progressed over the past five years is in very large part a measure of his skilful and tactful administration

Frances Braid

Mr. A. H Hamm

Albert Harry Hamm died at Oxford on January 9 at the age of eighty-nine During 1897–1931 he had been assistant to E B Poulton at the Hope Department of Entomology in the University of Oxford, and was well known as an ardent field naturalist of the old school

Trained as a printer, Hamm went to Oxford chiefly in that capacity to help Poulton in labelling the vast numbers of accessions , but Hamm was already recognized as an amateur entomologist of high degree He paid great attention to the courtship of predaceous flies (Empididæ), and his observations on their habits provided evidence of a complete evolutionary series He collaborated with the late Geoffrey Smith in a study of "Stylops and Stylopisation", and, with Dr. O W Richards, communicated to the Entomological Society of London, of which he was a fellow, two papers on the biology of British fossorial wasps Hamm added much to the knowledge of Sarcophagid flies by breeding many species from dead snails in his garden, so that it was possible for the first time to associate sexes correctly The small Agromyzid flies, often horticultural pests, were also bred, with their parasites, from their host plants

An expert photographer, Hamm was keenly interested in the early methods of producing lantern slides by direct colour photography , he also photographed moths in their normal resting places, showing the adaptive significance of attitude and coloration

His valuable collections, which he gave to the University of Oxford, included the Diptera and Hymenoptera mentioned above , to Dr O W Richards he had given his aculeate Hymenoptera Special collections of miscellaneous insects obtained from the nests of moles and birds will be kept intact at Oxford , the Diptera will be kept as the Hamm Collection

The University awarded him the honorary degree of M A in 1942 , he was an associate of the Linnean Society of London, fellow of the Society for British Entomology, and an honorary member of the South London Entomological and Natural History Society.

G D. Hale Carpenter

NEWS and VIEWS

Zoological Society of London : Dr. Edward Hindle, F R S

Dr Edward Hindle retires in April from the post of scientific director of the Zoological Society of London, which he has held since 1944 He is best known scientifically as a parasitologist, and worked for many years with G H F Nuttall in Cambridge In 1925 he went to China in charge of the Kala Azar Commission of the Royal Society, and, partly, in collaboration with Major Patton, established the method of transmission of the Chinese strain of *Leishmania* by *Phlebotomus* Afterwards he devoted most of his time to the study of yellow fever and spirochætes, doing pioneer work on yellow fever and preparing the first vaccine in 1928 He was the first to show that the virus of this disease, and also spirochætes, maintain their virulence in the frozen or the dried state He was also largely responsible for the introduction of the Syrian golden hamster from Aleppo as a laboratory animal

Dr Hindle was professor of biology at the Kasr-el-Aini School of Medicine in Cairo during 1919–24, and regius professor of zoology in the University of Glasgow during 1935–43 At Glasgow he was chairman of the Scottish Marine Biological Association and completed the extension of the Millport Laboratory He was the founder and first president of the Zoological Society of Glasgow, which resulted in the creation of a Zoological Park at Calderpark He has been a general secretary of the British Association for the Advancement of Science since 1946 and was president of Section D (Zoology) in 1947 He is president of the Zoological Section of the International Union of Biological Sciences, president of the Universities Federation for Animal Welfare, honorary director of the International Wildfowl Research Institute and first president of the Institute of Biology, in the establishment of which he took an active part He has always been to the fore in promoting the development of zoology in various ways and not the least valuable of his activities has been the editorship of the *Proceedings of the Zoological Society*

Dr L Harrison Matthews

Dr L Harrison Matthews has accepted an invitation from the Council of the Zoological Society of London to succeed Dr E Hindle Dr Matthews was educated at King's College, Cambridge, where he was Vintner Exhibitioner and gained the Frank Smart Prize of the University for zoology His interest in the living animal and its environment led naturally to some years on the scientific staff of the "Discovery" Expedition, and to expeditions in South America, tropical Africa, and elsewhere His numerous scientific contributions cover many aspects of zoology, but more particularly the anatomy and physiology of the reproductive cycle, and range in subject from basking sharks to hyænas and from fiddler crabs to the gorilla He has contributed monographs to the Discovery Reports on several species of whales, the seals, birds, and some invertebrates of the southern oceans, and on subjects of physical oceanography During the War he served first with Anti-aircraft Command and later with the Telecommunications Research Establishment, where he was concerned with the introduction of new radar devices into the Services Since the War he has continued his zoological work at the University of Bristol, where he is research fellow He has served for some years on the Council of the Zoological Society of London, and as vice-president He is also a member of council of the Marine Biological Association, a member of the National Committee for Biology, and of the Tsetse Fly and Trypanosomiasis Committee of the Colonial Research Council He was one of the British delegates to the last International Zoological Congress in Paris, and has served for a time as honorary secretary of the Association of British Zoologists Dr Matthews will take up his appointment on May 1 next, and will act as deputy secretary as well as scientific director to the Society

Baekeland Award of the American Chemical Society: Dr. L H Sarett

The American Chemical Society has recently announced that the Leo Hendrik Baekeland Award for 1951 has been given to Dr Lewis H Sarett, of Merck and Co , Inc , for his synthesis of cortisone This synthesis, which was made known by Dr Sarett in 1946 when he was twenty-eight years old, utilizes cholic and deoxycholic acid, derived from cattle bile, and entails thirty processes Since the drug is being used for the relief of arthritis, rheumatic fever, etc , it is required in much larger quantities than are available by the present method of production, and work is being done to simplify the synthesis Dr Sarett is a graduate of Northwestern University and gained his doctorate at Princeton University The Baekeland Award, which consists of a gold medal and 1,000 dollars, is sponsored by the Bakelite Division, Union Carbide and Carbon Corporation, and is conferred biennially upon an American chemist under forty years of age in recognition of accomplishments in pure or industrial chemistry The Award was founded in 1947 to commemorate the achievements of the late Dr Baekeland, the inventor of 'Bakelite' phenolic plastics

Large Sunspot Group seen through Fog

Fog prevailing in London and the Home Counties on January 29 and 30 produced the right conditions for seeing a big sunspot group with the unaided eye This group had come on to the sun's disk on January 23, and by virtue of the sun's rotation, passed across the disk to its western edge on February 3 On January 29, the spot group was therefore most nearly central, and many people became conscious of the black spot on the reddened solar disk The spots covered an area equivalent to about 1/650 of the sun's hemisphere , but a number of spots as large as this—some being double or even treble this area—have occurred during the past five years, that is, around the peak of the present, very active, 11-year sunspot cycle About seven out of ten sunspots of a size not less than that of the recent spot are associated with geomagnetic and ionospheric disturbance when the spots are within (roughly) the central half of the solar disk In the present case, no unusual disturbance was recorded

Venus and the Earth's Inner Core

Prof K E Bullen has written a paper entitled "Venus and the Earth's Inner Core" (*Mon Not Roy Astro Soc* , 110, 3 , 1950) which partly depends on a previous paper (*Mon Not Roy Astro Soc* , *Geophys Supp* , 6, 1 , 1950) In the latter, Bullen constructed an earth model, based on a previous compressibility–pressure hypothesis, in which there is a sharp density increase from 3 36 to 3 57 gm /cm ^{3} at a depth of 80 km., and thereafter a fairly steady density-gradient down to a depth of 2,700 km. The gradient increases sharply in the next 200 km., the density attaining 5·57 gm./cm.^{3} at the base of the mantle, while inside the central core it ranges from 9·74 to 12 gm./cm.^{3} at a depth of 4,980 km., and then rises sharply to a value of 17–18 gm./cm.^{3} at the centre. In Bullen's more recent paper it is shown that, assuming Venus and the earth are of the same primitive composition, it is probable that Venus also contains an inner core. The earth's inner core, as Bullen has previously pointed out, is chemically distinct from the rest of the earth, and the same is believed to apply to Venus and Mars also, the evidence being based on the mass and radius of Mars, the figure of Mars, and the mass and radius of Venus, assuming that the model mentioned at the beginning of the paper fits the earth. The ellipticity e of Venus can be derived from the formula $e = (1\cdot68 \pm 0\cdot07)10^{-6}y^{-2}$, if the period of rotation of Venus is $20\,y$ days. This formula, however, can be significant only if y is much less than unity, and present indications of the rotation period of Venus do not suggest this as being very probable. On the other hand, if y is of the order of unity, the value of e would not be resolvable by direct observation, and in any case would be dwarfed by surface inequalities sustained by the strength of Venus. For these reasons, little help can be derived from observations of the figure of Venus at present.

Parliamentary and Scientific Committee: Annual Report

The activities of the Parliamentary and Scientific Committee (31 Palace Street, London, S.W.1) have for the most part been noticed in *Nature* as they occurred; but the annual report recently issued also includes the text of a letter from the Minister of Education commenting on the Committee's report on technical education and indicating his readiness to receive a deputation. The Minister observes that he fully recognizes the importance of craft training and the need to combine organized practical training in the works with technical education in the colleges. While the Ministry is encouraging voluntary day release and the provision of more practical courses leading to qualifications of the City and Guilds of London Institute and the Minister shares the Committee's view as to the expansion of secondary technical schools, he doubts whether such schools are appropriate for technical education. Detailed surveys of industrial needs have already been made by most of the local authorities in preparing their Schemes of Further Education and plans for county colleges. The Ministry is doing its best to improve accommodation and equipment, and some £50 millions of new buildings were begun in the last year, the highest priority being now given to workshop and laboratory accommodation. Afterwards, on November 22, 1950, a deputation from the Committee discussed in detail with the Minister the implementation of these and other recommendations on which the Minister had commented. The report also includes the text of a letter from the Committee's chairman, Mr. Philips Price, to *The Times* (November 24, 1950) urging further effort to secure greater efficiency in the field of coal utilization, and an adequate investment for the installation both in factories and houses of the most efficient coal-burning and coal-using equipment that science and technology can devise, as well as the intensification of research in this field.

Division of Chemical Physics of the American Physical Society

The Council of the American Physical Society, as requested in a recent issue of *Physics Today*, has revived the idea of establishing a Division of Chemical Physics, and a committee consisting of Dr. F. G. Brickwedde, Prof. J. G. Kirkwood, Dr. J. E. Mayer, Prof. H. H. Nielsen and Prof. O. K. Rice, with Prof. R. S. Mulliken as chairman, has drawn up a draft set of by-laws. The principal objective of the new Division is stated to be "the advancement of understanding in subjects of chemical interest whose development depends strongly on modern physical theories or techniques". Membership of the new Division is open to all members and fellows of the American Physical Society on application. An entrance fee is payable, but no annual subscription. It is hoped to inaugurate the Division at the meeting of the Society in Pittsburgh during March 8–10, which will comprise a symposium on molecular structure and valence theory and on topics involving statistical mechanics. This will be followed in June by a symposium on molecular structure and spectroscopy.

Society of Plant Morphologists

During the recent annual session of the Indian Science Congress, held at the Indian Institute of Science, Bangalore, a large group of Indian botanists interested in plant morphology met on January 4 and decided to form a Society of Plant Morphologists. It was resolved that the Society should start a *Journal* devoted to all aspects of plant morphology from Algæ to Angiosperms and run it on an international basis. Pending formal election of office bearers some time next year, it has been arranged that Prof. P. Maheshwari, head of the Department of Botany, University of Delhi, Delhi 8, should act as convener of the Society and editor of the *Journal*. Inquiries relating to the Society and all subscriptions should be sent to Prof. Maheshwari. The annual membership fee is £2 for botanists residing outside India. For non-members the subscription to the *Journal* is £2 5*s*.

National Capital Wealth of Great Britain

In the annual report for 1949–50 of the National Institute of Economic and Social Research (pp. 32; from 2 Dean Trench Street, London, S.W.1), the approaching completion of a stage in the work of the Institute is announced, and its future plans are briefly explained. Hitherto, a large part of its resources have been devoted to the study of the national income of the United Kingdom and the establishment of the basic statistics in this field. The Institute now proposes to undertake a number of studies in the field of capital, of which the first will be a critical appraisal of historical estimates of the national capital, the concepts used, and the statistical methods and sources employed. Very little work, it is pointed out, has been done during the past fifteen years on the national capital, despite the greatly increased interest in the study of the national income, and despite the fact that in the nineteenth and the early years of the twentieth centuries frequent attempts were made to estimate the national capital. If feasible, these earlier estimates will be recalculated on a more uniform basis, and an attempt will also be made to link up estimates of the magnitude and composition of the national wealth with annual estimates of capital (or asset) formation. It is believed that it may be possible, in certain areas at any rate, to build up more detailed estimates of capital in different branches of industry according to type of real asset

The Peacock Butterfly in Scotland

A note by D W Hall in a recent issue of *The Scottish Naturalist* describes the present distribution of the peacock butterfly in Scotland Some twenty years ago the peacock was unknown in Scotland, but, by 1945, it was common in the Border country and was working steadily northwards, one isolated record from Caithness having been recorded The first recorded observation was made at Crinan, Argyllshire, in 1935, where, in 1948, it was reported to be common During the spring of 1948 it was reported as being the commonest species of butterfly near Oban, Argyllshire In Inverness-shire it became common in Canna and Eigg and was a well-established resident in the Hebrides by 1948, it can now be said to be quite common in the Western Highlands and Islands Records have also been made in central Scotland, while in eastern Scotland the peacock butterfly has become very common in Perthshire and Angus Migrating swarms as known in France and England have not been observed in Scotland

"The Rationalist Annual"

Originally published as the "Agnostic Annual", the "Rationalist Annual" is now in its sixty-eighth year of publication The 1951 issue maintains the high standard of its predecessors and includes articles by Prof J B S Haldane on the rate of evolution, J C Flugel on the present position of psycho-analysis, Robin Skynner on the Communist attitude to semantics, Avro Manhattan on arts and men, Lord Chorley on the growth of law, Archibald Robertson on grounds for disbelief in God, Maurice Burton on the impact of fear on animal behaviour, A Gowans Whyte on the recent memorandum prepared by the Religious Bodies Consultative Committee, F H George on psychology and semantics, Royston Pike on Edward Gibbon and, finally, D Stark Murray on the need for a rational attitude to health The journal is edited by Frederick Watts and may be obtained from Watts and Co, price 2*s* 6*d*

List of Periodicals in the Science Museum Library, London

A sixth edition of the "Hand List of Short Titles of Current Periodicals in the Science Library" (pp 282, London H M Stationery Office, 1950, 7*s* 6*d* net), which has recently been published, will be welcomed as giving a picture of the periodicals now being received at the Science Museum Library, London, but does not completely replace the older editions of the List Periodicals are entered only under their present titles, and there are no cross-references, although the holdings shown are those of the periodical under all its titles The List shows only the major gaps, however, and it is not a catalogue of all the periodical holdings of the Library A format based on photography from a visible index has been adopted instead of print, so as to facilitate re-issue Shelf marks are given at the end of the entries, and users are asked always to quote them when requisitioning The order of entries is that of the "World List of Scientific Periodicals", with the exception that journals, bulletins, reports, etc, of societies, institutions, etc, precede periodicals having distinctive titles commencing "Journal", "Bulletin", etc, and are not in one alphabetical order, as in the "World List"

Announcements

Dr E U Condon, director of the United States National Bureau of Standards, has been elected president of the Philosophical Society of Washington Founded in 1871, the Philosophical Society is the oldest Washington society devoted to the promotion of science, and its first president was Joseph Henry.

Colonel E H Thompson has been appointed to the University chair of surveying and photogrammetry tenable at University College, London The title of reader in geography in the University of London has been conferred on Mr A E Smailes in respect of the post held by him at University College

The Council of the City and Guilds of London Institute has conferred the fellowship of the Institute on the following past students of the City and Guilds College Dr G Roche Lynch, senior official analyst to the Home Office and director of the Department of Chemical Pathology, St Mary's Hospital, London, Sir Harold Saunders, recently Comptroller-General of Patents, Designs and Trade Marks and Comptroller of the Industrial Property Department, Board of Trade, Mr S Scott-Hall, principal director of technical development (air), Ministry of Supply, Dr R L Smith-Rose, director of radio research, Department of Scientific and Industrial Research, and Mr M T Tudsbery, civil engineer to the British Broadcasting Corporation

Mr Donald B Moore, district manager of North Eastern Trading Estates, Ltd, has been appointed general secretary of the Textile Institute, in succession to Mr Harry Ibbetson

The Medical Research Council, by arrangement with the Centre National de la Recherche Scientifique, is offering two scholarships, worth 40,000–60,000 francs a month plus marriage allowance, which are open to British graduates for research in medical science, excluding clinical medicine, to be conducted at research institutions in France during the academic year 1951–52 Candidates should have had some previous research experience and must possess a working knowledge of French Application forms, obtainable from the secretary, Medical Research Council, 38 Old Queen Street, London, S W 1, must be completed by March 31

A conference on "The Use of the Film in Training for Industry" has been arranged by the Scientific Film Association and will be held in the Hotel Majestic, St Annes-on-Sea, Lancs, during March 30–April 1 The main part of the programme, on March 31, will be divided into three broad sessions dealing respectively with films for training in the textile, engineering and building industries Both professionally-made and amateur-made films will be shown The fee for the conference is one guinea Further details can be obtained from the secretary of the Association at 4 Great Russell Street, London, W C 1

We are asked to point out that the Commission for Very Low Temperatures (*Nature*, January 27, p 138) is a commission of the International Union of Pure and Applied Physics, and not of Unesco, as stated Correspondence referring to the Commission's conference on low-temperature physics during August 22–31 should be sent to the Organizing Committee, Low Temperature Conference, Clarendon Laboratory, Parks Road, Oxford

SPONTANEOUS GELATION OF ALKALINE CASEIN DISPERSIONS

By K. F. PLOMLEY, H. G. HIGGINS and J. F. HAYES

Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Melbourne

SOME protein systems containing only monovalent alkalis, for example, casein – sodium hydroxide – water, are capable of spontaneous isothermal gelation without removal of solvent. Such a phenomenon clearly requires either direct interaction between the protein molecules or the intervention of alkaline degradation products, and is thus quite distinct from the gel formation observed, for example, in the presence of divalent cations[1] and aldehydes, which can provide bridges between free carboxyl and between amino[2] (or between amino and amide[3]) groups respectively.

In the system casein – sodium hydroxide – water, the gelation process has been found to be specific to a limited *p*H range. Experiments were carried out at 25° C. on two series, each of constant protein concentration, the final ratios of casein to water being 2:5 (series 1) and 2:7 (series 2) based on the air-dry weight of the protein. Solutions of different *p*H were examined in a Stormer viscometer in the manner described previously[4], and the dependence of the viscosity, η, on T, the time in minutes from the addition of the alkali to the protein, was determined, neglecting, for purposes of comparison, deviation from Newtonian flow and using the data for an actuating weight of 200 gm. Typical η—T curves are shown in Fig. 1. The 'rate of gelation', $d\eta/dT$, was obtained for an arbitrary value of T from the slope of the tangent to the η—T curve.

The dependence of η on *p*H is shown in Fig. 2 for $T = 60$ (series 1) and $T = 150$ (series 2); these periods were necessary to effect colloidal dispersion. As the η—T curves are essentially linear only below *p*H 12.5, their extrapolation to zero time has not been attempted; and small time effects are therefore included in the values of η plotted in the η—*p*H curve, which may account for the rise in the viscosity towards very high *p*H. However, the shape of the remainder of the curves is essentially valid, and resembles the behaviour of the sodium caseinate solutions of Nitschmann and Guggisberg[5]. The development of the net charge on the micelles as the *p*H of the protein solution is raised leads at first to a viscosity increase in accordance with Smoluchowski's effect[6]. At still higher *p*H the decline in viscosity may possibly result from reduction in the zeta-potential under the influence of cations adsorbed at the inner side of the diffuse double layer.

The variation of $d\eta/dT$ with *p*H, as shown in Fig. 2 for $T = 180$, is an indication of the extent of molecular interaction, although intramolecular effects are not necessarily excluded. In the region above *p*H 13.5 the viscosity at first increases rapidly with time, but later passes through a maximum (Fig. 1), and the subsequent decline is accompanied by a decrease in opacity, and the production of proteoses. The net decline in $d\eta/dT$ above *p*H 13.5 could be due in part to alkali inhibition of reactive groups; but the effect is so large that it must almost certainly be ascribed mainly to molecular breakdown, involving hydrolysis of peptide bonds. The maximum in the curve, reflecting the opposing effects of gelation and hydrolysis, further suggests that the new intermolecular bonds are less alkali-labile than some, at least, of the peptide linkages, since they are capable of forming under the conditions of peptide hydrolysis. The numerical superiority of the relatively labile peptide bonds eventually overwhelms the tendency towards gelation, which must operate initially at the surface of the protein molecule or micelle.

Evidence favouring the formation of stable covalent bonds is also to be found in the irreversibility of the gelation process. Gel material prepared at *p*H 13.2 was broken up in a Waring blendor, brought back to the isoelectric point of the original protein, dialysed to remove salt, and dried. Gelation with sodium hydroxide solution could not now be achieved. Further, the gel material was soluble in $M/15$ phosphate buffer to the extent of only 0.030 gm./100 ml. when 0.1 gm. was added to 100 ml. buffer, as against 0.87 gm./100 ml. for the untreated casein; even this low degree of solubility is probably attributable mainly to an interstitial sol fraction. Again, over a wide *p*H range, gels forming at *p*H 13.2 do not break down easily in excess water, although swelling of the order of 10–10² times the original volume indicates that the intermolecular network must be rather loose. For this reason also the gels are relatively weak and are easily deformed elastically under shear stress.

The possibility of the gelation mechanism involving a simple salt linkage seems to be inconsistent with the specific conditions of *p*H required. An examination of the characteristic acidity constants of the ionic groups of proteins[7] shows, for example, that in the trough in the $\frac{d\eta}{dT}$—*p*H curve of Fig. 2 (from

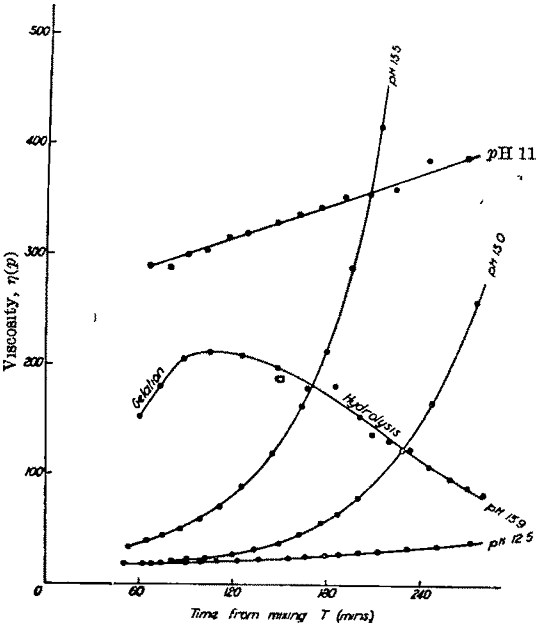

Fig. 1. Typical viscosity-time curves for different regions of the high *p*H range (series 1)

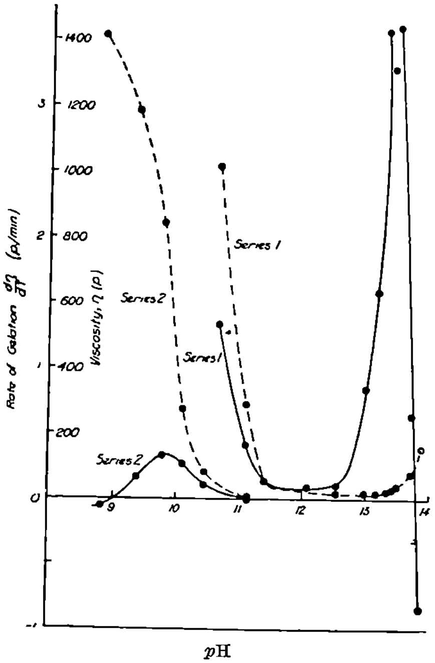

Fig 2 Dependence of viscosity, η, and rate of gelation, $d\eta/dt$, on *p*H ----, η, ——, $d\eta/dT$ for $T = 180$

c *p*H 11 5 to 12 5) oppositely charged side-chains would be more abundant than at higher *p*H, where $d\eta/dT$ is nevertheless much larger Further, at high *p*H the repulsive effect of strong net negative charges on adjacent micelles might be expected to hinder electrostatic attraction between oppositely charged specific groups Ion - dipolar ion interaction in the *p*H range 11 5-12 5 is not precluded, however, as shown by the fact that gels can form here in the presence of divalent cations (calcium)

In the region below *p*H 11 5, the increase in viscosity with time follows an approximately linear course (Fig 1) rather than $d\eta/dT$ increasing with time as it does above *p*H 12 5 The system finally has high viscosity but does not possess the rigidity of the high *p*H gels and is dispersible in water These results indicate different mechanisms for the two regions

In order to determine the possible effect of intramolecular changes on the gelation process, a series of investigations has been made into the properties of casein treated with sodium hydroxide solution at different *p*H values and protein concentrations After treatment for 60 min at 25° C, the systems were rendered isoelectric with hydrochloric acid and salt was removed by dialysis Viscosity studies were made at 21 8° C on dilute solutions of the various preparations in $M/15$ phosphate buffer using Ostwald tubes Axial ratios were calculated from the tables of Mehl, Oncley and Simha[8], using values of the increment of viscosity derived from the observed mean ratio, for three concentrations, of the specific viscosity to the concentration, and from the value of the partial specific volume for whole casein (0 73) given by McMeekin, Groves and Hipp[9] The viscosity increments are adjusted for an assumed degree of hydration of 0 4 gm solvent/1 gm protein[7], and if it is assumed that the molecules have the general shape of prolate ellipsoids, the mean axial ratios are as shown in the accompanying table for treatment groups relatively homogeneous in respect to viscosity increment There is no evidence of an unravelling of the polypeptide chains on the contrary, the molecular symmetry increases on treatment at high *p*H

AXIAL RATIOS OF ALKALI-TREATED CASEIN

Treatment		Mean viscosity increment (uncorrected for hydration)	Mean axial ratio, for hydration = 0 4
Casein water ratio	*p*H range		
2 5	9 7-13 4 13 4-13 9	17 8 3	8 5 4 6
1 225	10 4-13 2 13 2-13 5	19 11	9 1 5 8
Untreated		20	9 6

Evidence of denaturation has been observed among the other conventional criteria, but none suggesting unfolding of the chains After treatment with alkali, hydrogen sulphide is evolved upon return to the isoelectric point, this may be connected with a splitting of the molecule X-ray powder photographs of untreated casein and of casein at various stages of alkali treatment showed only the backbone and side-chain spacings of Astbury and Lomax[10], and no development of the outer ring corresponding to a Bragg spacing of 3 6 A which is characteristic of some denatured proteins, such as egg albumen

The search for the specific groups concerned in the gelation process, and their mode of linkage, is proceeding The work described here was carried out as part of the programme of the Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Australia We are indebted to Dr A B Wardrop of this laboratory for the X-ray photographs [Aug 1

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MYXOBACTERIA IN SOILS

Use of Rabbit Dung Pellets to Detect Myxobacteria in Soils

THE distribution of Myxobacteria in different types of soils has hitherto attracted very little interest The first investigation systematically carried out was made by the Krzemieniewskis[1], who in 1926 searched for them in Polish soils The method of isolation of Myxobacteria used by them was very simple, about 150 gm of the soil to be examined was distributed in large Petri dishes and a large number of autoclaved rabbit dung pellets were placed on the surface of the soil Species of Myxobacteria began to form fruiting-bodies within a few days In this way it was possible for the Krzemieniewskis to state that "Die Myxobakterien sind standige Bewohner des Bodens" (*l c*, p 139) From the frequency with which species of Myxobacteria occurred on the rabbit dung, they drew further conclusions on the influence of incubation temperature and of soil pH It is, however, very dangerous to draw definite conclusions from results obtained in this way, since it is not possible to standardize the quality of the rabbit dung, nor are the pellets in every case a suitable substratum for the development of the majority of Myxobacteria

Attempts to isolate Myxobacteria were made in 1949 in Uppsala, and during the summer of 1950 at Rothamsted Experimental Station In these experiments use was made of dung pellets—fresh and stale —from tame rabbits Before use, the pellets were washed in water and autoclaved at about 15 lb /sq in for 10 min About twenty of these were placed on the surface of the soil sample in a Petri dish which was incubated at 25° C In the investigations at Rothamsted, the presence of Myxobacteria in soil was also tested by Singh's method[2] *Aerobacter* (strain 1912 [3]), grown on nutrient agar slopes for six days, was spread on the surface of non-nutrient agar (1 5 per cent agar, 0 5 per cent sodium chloride) of pH 6 6–7 2 to form a 'bacterial circle', about 2 5 cm in diameter Three such circles—here called '*Aerobacter* circles'—were made in each Petri dish and about 0 5 gm soil was placed in the centre of each circle Each soil was tested on six circles The plates were incubated at 25° C for three weeks

Seventeen soils were examined and in all of them Myxobacteria were found The number of Myxobacteria found on rabbit dung was quite different from that found on the '*Aerobacter* circle' A comparison of the results is summarized in the accompanying table

Growth of Myxobacteria from Seventeen Fresh Soil Samples on Rabbit Dung and on '*Aerobacter* Circles'

Substratum for isolation	Number of soils with			
	Myxococcus virescens	*Myxococcus fulvus*	*Chondrococcus coralloides*	*Archangium* sp
Rabbit dung	2	1	10	6
'*Aerobacter* circle'	14	3	11	0

Myxococcus virescens was obtained from fourteen soils on '*Aerobacter* circles' but only from two soils on rabbit dung Thus in twelve cases this species, although present in the soil, did not develop on rabbit dung The same tendency is shown by the rarer species *Myxococcus fulvus* This shows that failure to find Myxobacteria on rabbit dung pellets does not necessarily indicate that they were absent from the soil examined It indicates rather that the rabbit dung was an unfavourable medium for this species

On the other hand, *Chondrococcus coralloides* developed on the pellets almost as well as on the '*Aerobacter* circles'

In the earlier investigations in Uppsala, it was very easy to obtain *Myxococcus virescens* and *Myxococcus fulvus* on rabbit dung[4] In these experiments fruiting bodies of the genus *Archangium* were also found frequently These were always very large, visible to the naked eye and of a reddish-blue colour In the experiments at Rothamsted the fruiting bodies of *Archangium* were small and mostly with few convolutions Their colour was generally white or sometimes pale red Thus it seems that the rabbit dung pellets used at Rothamsted provided a substratum quite different from those used at Uppsala

These observations show that rabbit dung pellets do not constitute a constant substratum, and hence that comparable results concerning the distribution of Myxobacteria in different types of soil cannot be obtained by their use

Singh's method of isolation from soil has the advantage that the Myxobacteria can develop on a standardized medium It is not clear in these experiments why *Archangium* did not develop on '*Aerobacter* circles', as Singh[2] reports having found it by this method It may not have been abundant enough to occur in 0 5 gm. of soil It is possible that Singh's method would yield more Myxobacteria if the 'bacterial circle' were composed of a different food bacterium or a mixture of two or more bacterial strains It is also possible that the content of 0 5 per cent sodium chloride in the agar prevents some species from developing

[1] Krzemieniewski, H and S , *Acta Soc Bot Pol* , 5, 102 (1927)
[2] Singh, B N , *J Gen Microbiol* , 1, 1 (1947)
[3] Singh, B N , *Ann App Biol* , 28, 52 (1941)
[4] Norén, Borje, *Sv Bot Tidskr* , 44, 108 (1950)

Effect of Soil Treatment on the Occurrence of Myxobacteria

In view of the antibiotic action of some species of soil Myxobacteria, their relative abundance in different soils becomes of interest A search for these organisms in various soils was made, using the method of '*Aerobacter* circles' described by Singh[1]

In all, seventeen different soils were examined at Rothamsted during August 1950 These included samples from plots receiving, respectively, no manure, farmyard manure and complete minerals plus ammonium sulphate on Broadbalk and Barnfield at Rothamsted and on Stackyard Field, Woburn, Beds The Broadbalk plots have received the same manures since 1843, the Barnfield and Woburn plots since 1876 The remaining eight soils were collected from other fields in Rothamsted and Woburn

Myxobacteria were obtained from every soil The species were *Myxococcus virescens*, *Myxococcus fulvus* and *Chondrococcus coralloides* Fruiting-bodies which appeared to be of *Polyangium fuscum* were also found, but as they have not yet been obtained in pure culture definite classification is not possible

A satisfactory method of counting Myxobacteria in soil is still lacking In this investigation an attempt was made to assess the frequency of one species in a soil by counting the number of '*Aerobacter* circles' in which it developed Each soil was tested in six circles With this method of assessment, the untreated soils from Broadbalk, Barnfield and Stackyard Field formed one group, those from the complete mineral-treated plots a second group and those from the farmyard-manured plots a third group Each group contained three soils and was thus tested in eighteen '*Aerobacter* circles' Although this number is not sufficient to permit definite conclusions, some observations can be made

(1) *Myxococcus virescens* was found most often and *Myxococcus fulvus* least frequently

(2) No differences were observed in the abundance of Myxobacteria as between untreated and complete mineral-treated soils

(3) All three species were found most frequently in the farmyard-manure treated plots This may be due to the greater number of suitable Eubacteria or to the farmyard manure itself favouring the growth of these Myxobacteria

The relation of occurrence to soil reaction was examined in twelve of the seventeen soils These fell into three groups acid soils (pH 4 1–5 5)., neutral soils (*p*H 6·8–7·1), alkaline soils (*p*H 7·2–7·9) Each group included four soils and was thus tested on twenty-four '*Aerobacter* circles' The influence of the soil reaction on the number of Myxobacteria that developed is shown by the accompanying table

DISTRIBUTION OF MYXOBACTERIA IN SOILS OF VARYING *p*H (24 REPLICATE '*Aerobacter* CIRCLES' TESTED)

*p*H of the soil group	Number of '*Aerobacter* circles' in which have grown		
	Myxococcus virescens	*Myxococcus fulvus*	*Chondrococcus coralloides*
4·1–5·5	3	0	7
6·8–7·1	13	1	10
7·2–7·9	17	4	3

In a laboratory experiment, *Myxococcus virescens* was found to have its optimum *p*H about 7, its activity decreasing very rapidly on the acid side and more slowly on the alkaline side[2] The distribution in field soils thus agrees with the results of this experiment Concerning the other two species no clear differences were shown The decrease in number of *Chondrococcus coralloides* and the increase of *Myxococcus fulvus* is suggestive, but pure cultures of these species must be tested before any definite conclusion can be drawn

My stay at Rothamsted Experimental Station was made possible by a grant from C F Liljewalch's Stipendiefond, University of Uppsala I wish to express my thanks to Dr. H G Thornton for giving me facilities to work in his department and to Dr B N Singh for guidance and advice in this work

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[1] Singh, B N, *J Gen Microbiol*, 1, 1 (1947)

[2] Norén, Borje, Proc VII Int Bot Congr Stockholm, 1950 (in the press)

ROCKEFELLER FOUNDATION

REVIEW FOR 1949

IN a review for 1949 of the work of the Rockefeller Foundation*, the president, Mr Chester I Barnard, points out that political changes have prevented the Foundation from operating in Poland, Czechoslovakia, Hungary and China, in which it was formerly active Moreover, although until recently the Foundation was a principal source of funds for foreign student fellowships at the advanced level, appointments now made annually by the Foundation constitute scarcely two per cent of the 15,070 comparable awards now offered, of which 62·5 per cent are by government agencies Together with that of the General Education Board and of the Carnegie Corporation, the income of the Foundation is now less than one per cent of the budgetary needs of the 1,800 institutions now ministering to higher education, as against more than 15 per cent when the Foundation was launched in 1913 In the first part of the report the president discusses the comparatively modest yet significant part which a privately endowed philanthropic organization can play under present world conditions Income in 1949 was 10,984,000 dollars, and net appropriations amounted to 10,276,525 dollars Annual income from present assets is expected to average 8 million dollars, but the Trustees have reaffirmed the policy of using principal up to a level of two millions annually for projects of exceptional significance the needs of which can be met only through the Foundation

In education, the Board of Trustees has decided to limit its programme to the advancement of education in the southern States, apart from assisting certain projects rendering broad, general services to education, such as the Commission on Financing Higher Education of the Association of American Universities, the Conference Board of the Associated Research Councils and the American Council on Education The Commission was granted 4,000,000 dollars in 1949 towards a three-year study, while the Conference Board received a further grant of 120,000 dollars for a two-year study of the nation's human resources in relation to the needs in the fields of higher learning

This new policy was adopted to avoid the excessive discrimination which a highly selective distribution in this field would involve, but the Board is well aware of the value of small grants and in general looks for opportunities which will be strategic in terms of human welfare rather than necessarily involving large sums of money Moreover, as Mr Barnard emphasizes, although there are some scientific activities which require great capital outlays or large groups of workers, in the research field it is the small and successful plantings which most frequently lead to new forests The chance of eventual success is increased if a limited initial input is followed by increasing support based on a record of achievement, and Mr Barnard indicates how the Foundation throughout its history has developed scientific leadership in this way The ten thousand fellowships, aggregating twenty-five million dollars, which the Foundation has awarded during the past thirty-five years represent investments in intellectual capacity, imagination and character and, in particular, have contributed to the remarkable progress in public health during the past twenty-five years

Referring to the scheme set forth in the 1948 report for the comprehensive study of problems of population, communication and co-operation, Mr Barnard states that the phrase 'human ecology' has now been adopted in place of the narrower term 'population', as more descriptive of the range of problems in which the officers of the Foundation are seeking to discover gaps in interest and research in the academic world The meaning of the word 'communication' has also been misunderstood, and Mr Barnard points out that it embraces all those aspects of the broad problem of human communication which break down the dividing lines between the conventional disciplines and bring to light new fields for exploration Natural science, medical science, social science and humanism can no longer exist in separate and self-contained spheres, and the new ties between them make for a more vital understanding and perhaps even mastery of the world of knowledge as a whole Furthermore, while the Foundation was established originally on the premise that the welfare of mankind could be advanced through an increase in knowledge, it has become more and more clear that the most important knowledge is that which concerns human beings, and that the key to the attainment of dignified and rational existence for all men depends essentially upon a vastly improved understanding of human behaviour, to be achieved by a synthesis of effort to which all disciplines contribute

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* The Rockefeller Foundation a Review for 1949 By Chester I Barnard. Pp 85 (New York Rockefeller Foundation, 1950)

It is the policy of the Foundation to stress activities that promise to increase man's understanding of himself, and examples are cited of growing co-operation of the sciences and the humanities in common problems One such venture, the Mexican agricultural programme, which in six or seven years has led Mexico well on the way to self-sufficiency in the production of corn and other staple foods, has led to an invitation to lend technical leadership to a Columbian programme in agriculture The Sardinian malaria control campaign promises to wipe out the malaria problem of that island, and, after three years of intensive work towards which the Foundation will have contributed 375,000 dollars by the end of 1950, malaria is no longer a threat in Sardinia An invitation from the Greek government to survey socio-economic conditions in Crete was accepted, and it is hoped that the survey will indicate the most strategic and helpful points of attack in any programme of economic development

Two major grants of the Foundation in 1949 were for additional studies of the Near East One, of 83,000 dollars to the American University of Beirut, was for interpretative studies of the life, thought and tradition of the modern Arab Middle East The other provided 25,000 dollars to the American Board of Commissioners for Foreign Missions for studies of intellectual and cultural movements in modern Turkey A number of grants were made for studies of interpersonal and intergroup relations Of these, one to the Laboratory of Social Relations at Harvard University provides for a comparative study of the value systems of the Navaho and four other culture groups At Yale University, members of the Institute of International Studies are studying the conditions essential to a more extensive international consensus, or voluntary accord, and the means of achieving it, while assistance has also been given to the University of Notre Dame for its research programme in international relations and to the Institute of Industrial Relations of the University of California for a study of the social, political and economic impact of an ageing population on American society The Institute for Personality Assessment and Research at Harvard University was also established in 1949 with the aid of a three-year grant of 100,000 dollars from the Foundation, while a three-year grant of 121,200 dollars was also made in 1949 to the Tavistock Institute of Human Relations

The Foundation has provided 50,000 dollars, available until the end of 1951, for the Institute of Andean Biology for equipment, and the new knowledge of high-altitude physiology that is expected to emerge from the research at the new Institute should contribute not only to progress in aviation but also in the treatment of disease An outstanding feature of the year was the discovery in work on yellow fever by the Foundation's research staff in East and West Africa, Brazil and Columbia of a group of eighteen tropical viruses, of most of which very little is known An international survey to determine the geographical distribution of these viruses is planned, and their physical properties and chemical components, the responses to them in animals, the immune responses and cultivation of the viruses in chick embryos are all being investigated, with the view of relating the viruses to each other or to known agents, establishing criteria for laboratory diagnosis of each infection, and determining how the viruses enter the body and what kind of damage they do Already, however, it can be said that the Foundation's thirty-five years of work in this field have yielded a good understanding of the epidemiology, diagnosis and prophylaxis of the disease Effective control measures are now available wherever and whenever yellow fever again invades urban populations

The number of applications to the Foundation for aid again increased, and in 1949 3,017 were declined as compared with 2,702 in 1948, 2,510 in 1947, 1,839 in 1946 and 1,028 in 1945 Of these, 1,133 were for fellowships and travel and training grants While many of the applications represented projects of interest to the Foundation which were declined because other opportunities seemed more promising, most of the applications that were declined fell outside the areas of work in which the Foundation is now attempting to be of service.

COLONIAL RESEARCH AND DEVELOPMENT[*]

THE Return of Schemes made under the Colonial Development and Welfare Acts records in detail how the sum of £13,361,281, twice the amount of the previous year, is to be expended in grants of £11,010,168, loans of £555,114 and research grants of £1,795,999 on the more than five hundred new schemes approved during 1949–50, of which 142 were for research Schemes previously approved under the Act amounted to £56,821,426, with £6,219,908 for research schemes , thus, by March 31, 1950, more than half of the £120,000,000 authorized under the 1945 Act had already been earmarked for approved schemes Agricultural development took up more than £2,000,000 of the expenditure last year —£1,949,991 for development and £113,608 for research Water supplies and sanitation accounted for £1,046,720, primary and secondary education for £874,393, technical and vocational education for £657,634 and higher education for £934,637, training schemes for the Colonial Service for £501,527, forestry for £232,821, fisheries for £138,513, medical and health services for £632,258, physical planning and surveys for £673,752, roads for £1,177,956, medical research for £514,855, social research for £326,148, fisheries research for £290,918, and insecticides research for £241,465

Of the research schemes, the largest two are £200,000 for the West African Virus Research Institute at Lagos, and £150,000 for the expansion and maintenance of the corresponding East African Institute at Entebbe, 1950–55 £137,000 goes for the maintenance for five years of an institute for research and training in fish farming at Penang, and £100,000 for the continuance for five years of the work of the Rhodes–Livingstone Institute in Northern Rhodesia, while £74,800 is provided for the establishment of the West Indies Institute for Social and Economic Research £74,000 is provided for continuing the work of the East African Insecticides Research Unit for three years, £90,000 for continuing for five years the work of the Anti-Locust Research Centre, £76,000 for the establishment of an East African Marine Fisheries Research Survey in Zanzibar and £53,000 for the establishment of a West African Institute of Social and Economic Research The establishment of a Fisheries Research Organization to serve Northern Rhodesia and Nyasaland receives £62,000, and £55,000 is provided for the establishment of headquarters in Tanganyika of the East African Insecticides Research Unit, £65,000 for experiments with the dissemination of insecticides from fixed-wing aircraft, £31,912 for research on bananas, soils, cocoa, and sugar technology at the Imperial College of Tropical Agriculture, a further £30,300 for the establishment of the Colonial Microbiological Research Institute, £47,000 for the formation of a filariasis research unit in East Africa, £19,500 for establishing an East African Malarial Unit, £10,500 for the construction and equipment of an East African Herbarium at Nairobi, and £16,616 for the establishment of a Tsetse Fly Research Unit in Northern Rhodesia Supplementary capital provision for the East African Agriculture and Forestry and Veterinary Research Organizations amounts to £21,000, besides £14,955 for the investigation of the incidence of loiasis in the British Cameroons, £9,300 is provided for capital expenditure on research on the incidence of loiasis in Nigeria Hot-climate physiology research in Nigeria receives £11,839, fundamental insecticides research at University College, Ibadan, £7,000, and the establishment and maintenance for five years of an Institute of Educational Research to serve Fiji, the British Solomon Islands Protectorate and the Gilbert and Ellice Islands, £21,017 A grant of £18,813 is for assistance towards the expansion and operation of the Elini Livestock Experimental Station, British Guiana, and one of £17,600 for research to ascertain causes of the swarming of the Moroccan locust and the best means of prevention, £20,000 is provided for the formation of a small pool of entomologists to undertake short-term investigations in the Colonies, especially in smaller territories which have no government entomologists on their establishments Other miscellaneous grants provide for six postgraduate studentships for two years training in insecticides research, for fundamental research on Colonial insecticide problems at Rothamsted Experimental Station and at the Field Station of the Imperial College of Science and Technology, for Colonial medical research studentships, for the appointment of Colonial liaison officers at the Pest Infestation Laboratory and the Road Research Laboratory of the Department of Scientific and Industrial Research, and for research at the Lister Institute of Preventive Medicine into the preparation of precipitin sera for entomological investigations of malaria, trypanosomiasis, etc

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[*] Colonial Development and Welfare Acts Returns of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the Period from 1st April 1949 to 31st March 1950. Pp 73 (London H M Stationery Office, 1950) 1*s* 9*d* net

Nor does this indicate the full extent of the demands now being made by the Colonial Development and Welfare Schemes on the resources of Great Britain both in finance and in man-power Besides the schemes listed specifically as research schemes, such general schemes as the desert locust survey and emergency control measures and the establishment of a malarial unit must also make appreciable demands on scientific man-power and on finance Only a few of such schemes can be mentioned here, but the development plan for Uganda for which £697,000 is allotted, the control of 'sudden death' disease of cloves in Zanzibar (£193,000), the livestock diseases survey in Nyasaland (£39,970), geological surveys in Northern Rhodesia (£67,600), Bechuanaland (£23,340), Cyprus (£46,000), North Borneo and Sarawak (£107,650), Gold Coast (£21,200), the control of yaws in Jamaica (£45,512), tsetse control in Northern Nigeria (£355,960), the development of water supplies in Malta (£536,800), are schemes which sufficiently illustrate the variety and magnitude of the demand they make on the resources of Great Britain This is quite apart from what is involved in such grants for higher educational development as that of £332,821 for the first stage of development of the permanent University College at Ibadan, Nigeria, the miscellaneous grants for the University College of the West Indies, including £207,000 for the construction of permanent buildings, £565,834 for the construction and equipment of a new technical college for the Federation of Malaya, £82,917 for an agricultural experimental station at Trinidad, and the £58,638 for completing the building programme of the Imperial College of Tropical Agriculture The numerous grants for the Colonial Service training schemes, for agricultural development, fisheries development, forestry, road development and the Caribbean Medical Centre and the Suva Medical Centre, Fiji, all likewise represent a considerable contribution both of scientific man-power and of financial resources the magnitude of which is probably not generally appreciated, but may well bring a rich return to Great Britain as well as to the Colonial peoples

GOLD MEDAL OF THE ROYAL ASTRONOMICAL SOCIETY

AWARD TO PROF J STEBBINS

LAST year the Gold Medal of the Royal Astronomical Society, which had been awarded to Prof Joel Stebbins, was presented to Dr C S Piggott, scientific attaché to the American Embassy in London, acting as proxy for Prof Stebbins, who was unable to be present Prof W M Smart, president of the Society, delivered a presentation address which described the work of Prof Stebbins and his specialization in photometric observations of practically every class of celestial bodies except meteors and planetary nebulæ This address by the president has been published in full (*Mon Not Roy Astro Soc*, 110, 2, 179, 1950)

Soon after going to Urbana Observatory in the University of Illinois in 1903, Prof Stebbins commenced experiments with selenium cells, some of which he made himself, but the Dutch firm of Giltay, at Delft, produced the most satisfactory one The first successful observations were made on the moon, and Prof Stebbins found that the light of full moon is 0 22 candle-metres At half-moon during the first quarter, the brightness is only 12 per cent of that of the full moon, and at last quarter it is reduced to 10 per cent. This is due to the irregularities of the lunar surface, the dark seas covering a large portion of the sunlit area during the last quarter During a partial eclipse of the moon, he found that the instant of minimum light took place within 0 6 min of the time predicted by the ephemeris The selenium cell was also used to determine the light-curve of Algol, with very satisfactory results For the first time the secondary minimum was observed, and the discovery at the same time of a continuous variation on either side of the secondary minimum suggested that the fainter component B has an axial period of rotation equal to its orbital period of revolution with respect to the brighter component A In addition, the hemisphere of B exposed to the radiation from A is brighter than the other hemisphere, this was the first time that this 'reflexion effect' had been observed When Stebbins took up the study of Algol ten years later, using the more accurate photo-electric photometer, not only were the general features of the binary as determined with the selenium cell confirmed, but also another effect arising from the slightly ellipsoidal shape of the components was detected

Algol, however, was one of the exceptions to Eddington's mass-luminosity relation on the assumption that the mass of A was 0 37 that of the sun and the mass of B half that of A Later, when McLaughlin and Rossiter, using a new method, applied it to the solution of the binary problem, it was found that A was five times as massive as B, and A then satisfies the mass-luminosity requirements, thus vindicating the accuracy and importance of Stebbins's work

At the total solar eclipses of 1918, 1925 and 1937, Stebbins measured the integrated light of the corona with his photo-electric apparatus, and concluded that there is little evidence of any noticeable variation of the total light of the corona during the sunspot period Another interesting result was that the light of the corona, photo-electrically, is about one-half that of the full moon From the absence of evidence of the Rayleigh scattering, it was inferred that the continuous and Fraunhofer spectrum can be produced by electrons or large dust particles, but not by atoms, molecules and particles of wave-length dimensions Finally, over a large range of wave-lengths the intensity distributions for the sun and corona are the same—a fact which must be taken into consideration by all who formulate any general theory of the corona

It is impossible to refer to all the branches of Stebbins's work, and it will be sufficient to mention one or two others of outstanding importance In 1930, when he visited Lick Observatory, he turned his attention to an extensive observational programme on stars (starting with B stars), globular clusters and extragalactic nebulæ This programme was so comprehensive and so important that it is well worth reading Prof Smart's address to realize the implications of some of the results obtained It may be mentioned that the evidence obtained from the globular clusters led to a revision not only of their individual distances but also of the diameter of the galaxy, which was shown to be considerably less than that of Shapley's original estimate and is now believed to be about 100,000 light-years or less. This reduction in the dimensions of our galaxy, combined with Stebbins's work on the Andromeda nebula with the photo-electric observations of its outlying regions, which showed it to be considerably larger than was originally believed, has led to the conclusion that there is little difference in the overall dimensions of the two systems

In 1947 Stebbins attempted to locate the central nucleus of the galaxy Using the 60-inch telescope at Mt Wilson, the galvanometer deflexions for the infra-red filter (10,300 A) and also for a red filter (7,190 A.) were noted in narrow zones, with the telescope stationary, in the neighbourhood of 326° galactic longitude The observations extended over several degrees in longitude and latitude, and the maxima of the infra-red readings appeared to indicate a bulge An analysis of the space-reddening showed that the light of the bulge, extending over 8° in longitude and 4–5° in latitude, when corrected for absorption, is comparable with the light of an equivalent section of the Andromeda nebula The position, outline and total light of the bulge suggest that something is being detected near the galactic centre, but Stebbins makes no greater claim than this

Prof Stebbins's work is well summed up at the end of Prof Smart's address "In surveying our Medallist's work over the long period of nearly fifty years one cannot but be impressed by his devotion to one great department of astronomy which he in great measure has made his own by his observational skill, his attention to detail and his critical analysis of the new and unexpected phenomena which his observations have brought to light".

INSTITUTION OF GAS ENGINEERS

AUTUMN RESEARCH MEETING

THE sixteenth autumn research meeting of the Institution of Gas Engineers was held in London during November 28–29, 1950, with Mr F M Birks as president

Like other public services, the gas industry has problems of peak load, if of less intensity Normally they are met by the use of carburetted water gas, a product which makes the combined use of gasified coke and mineral oil H Stanier and J B McKean described a new process based on the gasification of mineral oil, blended with steam and heated in contact with a suitable catalyst Under suitable conditions the product is a gas of composition and character similar to normal town's gas, and can be used for supplementing the latter at peak periods From economic considerations this process might provide an alternative to gas manufactured from coal

At the present time, the sulphur available from home sources is obtained by the purification of coal gas The normal methods of recovery, although efficient, have certain practical difficulties, and any improved means might be an important contribution to the national economy E Johnson described an attempt to recover sulphur of high purity from the spent oxide of gas purification practice using a fluidized technique and solvent extraction A sulphur product of 95 per cent purity is obtained, and the extracted oxide has a reactivity to hydrogen sulphide not greatly different from that of the original material The work has shown that a semi-continuous process for the extraction of sulphur from spent oxide in a fluidized bed by means of solvents is possible, and no fundamental difficulties are likely to be encountered in making the process fully continuous A large-scale fluidized process was proposed for further investigations

The importance of combustion research in gas utilization was emphasized by J E Garside in a review of the field of relevant research Flame propagation, flame stability, mechanism of combustion reactions, heat and energy release, heat and energy transfer, and ignition of gas–air mixtures were all briefly dealt with, and the extent of present-day knowledge indicated Some of the major questions facing gas utilization in the industry at the present time were stated, and an attempt was made to answer them by explaining the findings of current researches in Great Britain and correlating those findings with the results of similar projects overseas

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Flying-spot Microscope

SURPRISINGLY little of the information obtained with microscopes has been quantitative; most observers are content to sit at the microscope and regard the image, or to photograph it. Theoretically, it is possible to scan the image or its photograph mechanically, but this has seldom been done in practice. The whole method of obtaining resolution by lenses involves so much loss of light, lack of control of contrast, and other difficulties, that it is difficult to provide a good display or method of scanning.

Some of these difficulties can be avoided by using a wholly different means of obtaining resolution and amplification. The essence of the problem of resolution is to separate in some way the light passing through very close regions of an object. The conventional microscope does this by using refraction by lenses to separate the light from neighbouring regions. An alternative method is to use the lens system the other way round, namely, to produce a minute spot of light. Discrimination between neighbouring points is then produced by passing the light through them at different times by making the spot scan it. After passing through the preparation, the spot is made to fall on a photocell, with subsequent amplification and display as required. Such a flying-spot microscope depends on scanning different parts at different times, and will only give accurate information about objects that are stationary or moving only at a rate of a different order from that of the spot.

The method is based on the well-known technique of flying-spot scanning by two cathode-ray tube rasters locked together. In front of the eyepiece of a microscope is placed a tube providing a televizing raster of high brilliance and very short time-constant. The microscope objective thus produces a minute spot of light that scans the preparation to be examined. The amount of light transmitted is determined by the density of the specimen and is picked up by a multiplier photocell. The output of this is used for modulating the raster on a second cathode-ray tube, of projection type.

This combination of optical and electronic techniques provides all the facilities of conventional microscopy, with important additional advantages, among which are the following: (1) A projection display some three foot square and of brightness several foot-lamberts can be obtained. This method of display has substantial advantages, not only for discussion and teaching, but also for measurement and indeed for ordinary surveying of preparations. (2) Since the size of scanning raster can be continuously varied, there is less need for changing of objectives. (3) The brightness of the image is readily controlled. (4) Since the contrast is determined by the amplifier gain as well as by the density distribution, contrast can be made greater, or less, than in the original specimen, with obvious advantages in studying unstained, or vitally stained, or overstained specimens. (5) It should be possible to produce visible displays, with incident radiation of a wave-length of at least from 2,000 A. to 10,000 A. (6) The quantum efficiency of the photocell is greater than that of the photographic plate by at least 100 : 1 at 2,650 A., making it proportionally easier to avoid producing alterations in living specimens. (7) Resolution in the ordinary microscope is affected by the halation produced by interference between neighbouring particles. Since only one resolvable region is illuminated at a time, resolution should be substantially greater with the flying-spot than with the conventional microscope. This possibility has not yet been systematically explored experimentally. (8) Perhaps the most important of all advantages is the possibility of quantitative analysis. The output of the photocell has a voltage-time distribution known as a time series, and can therefore be analysed by well-known techniques to give histograms and spectrograms of the specimens. Particles could probably be counted and sized at a rate of a million per second.

The first model that we have built suggests that these advantages can be realized, and further development is being undertaken.

This work has been made possible by a grant from the Nuffield Foundation.

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Extra-Corticle Membranes and Layers of the Wool Fibre

IT has been shown[1] that peracetic acid renders wool freely soluble in dilute ammonia, except for a small fraction which appears as a tubular membrane. By prolonging both these treatments, it has been possible to obtain further evidence in support of the theory concerning the structure of the outer layers of the wool fibre put forward by Reumuth[2], Lehmann[3], Swerdlow and Seeman[4] earlier, Lindberg, Philips and Gralén[5], and Zahn and Haselmann[6] more recently.

Extracted wool fibres were fixed by means of a solution of methyl methacrylate to an open frame which would accommodate a microscope slide. They were then suspended in peracetic acid for five days. After washing they were immersed in ammonia for a further seven days. The remains of the fibres had an appearance rather like transparent soft elastic and were quite fragile.

Microscopic examination showed them to be membranes similar to those illustrated by Alexander and Earland[1]. In view of the strong evidence supporting the existence of an epicuticle membrane[6–8], I attempted to break this major membrane with micromanipulators, hoping that if I could dislodge such an epicuticle I would be able to see some trace of it. This actually happened. The operation of sliding this very transparent sheath off the comparatively bulky major membrane was a hazardous one, and it was only in three attempts out of several on each of a hundred fibres that success was achieved. Although it was invisible in a bright field, by using the phase-contrast microscope and the very minimum of illumination, the first example was seen. The micrograph of this involved a 30-min. exposure with a 23 Scheiner orthochromatic plate (Fig. 1). Later, a better result was obtained with a 30 Scheiner plate. In both these cases a thin membrane was removed from the part of the major membrane shown in the micrograph.

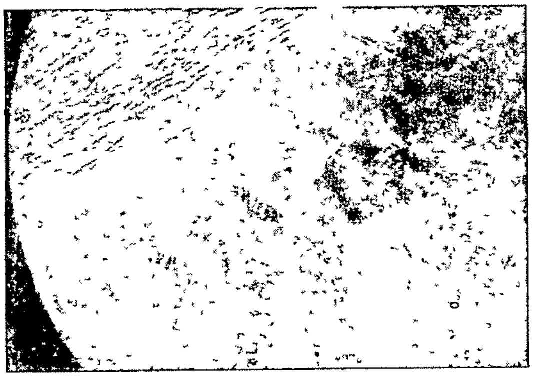

Fig. 1. Epicuticle membrane of wool fibre (phase-contrast micrograph. × 400)

The most outstanding feature of this demonstration is that on the original major membrane there was no appearance of scales, and yet the thin epicuticle membrane shows definite scale-shaped marks (Fig. 1).

In one or two of the fibres there were small sections where the major membranes did show scale marks. In these cases the scale marks exhibited some amount of birefringence, showing that there was definitely scale material present, probably because these patches had, for some reason, received a slightly lighter treatment. One of these fibres broke while being mounted on the microscope slide. It assumed a folded shape, demonstrating its thinness, but still showed the shapes of scales on its surface. Fig. 2 shows this fibre, using phase contrast and between crossed 'Polaroids'. Those scale edges which were more clearly defined in ordinary light showed marked birefringence. Repeated attempts were made to slide the outer sheath off the membrane, but in no case was it possible. This, of course, may have been due to the high probability against the mechanics of the process, but the remains, after these attempts, did not have the same appearance as those previously mentioned. The impression gained led to the conclusion that there was material below the outer membrane acting as an adhesive.

The results obtained are interpreted as follows. The membrane as depicted by Alexander and Earland[1] represents the sub-cuticle membrane[2,3,9,10] or *Zwischenmembran*[6]. In some cases there was evidence of a thin outer sheath, the 'epicuticle'[6,7,8,10]. Below this and above the sub-cuticle membrane is some material possessing considerable birefringence and which appears to constitute part of the scales. Although it is not possible to see anything as thin as the epicuticle with the optical microscope, with the phase-contrast microscope it is possible to see quite clearly differences of intensities representing only 300–400 A. It is such differences of intensity that are shown in Fig. 1. The outlines of the scales are visible most probably because of small amounts of endocuticle which may remain because it is chemically more resistant[5,9,10]. In Fig. 2 the birefringent edges are almost certainly endocuticle.

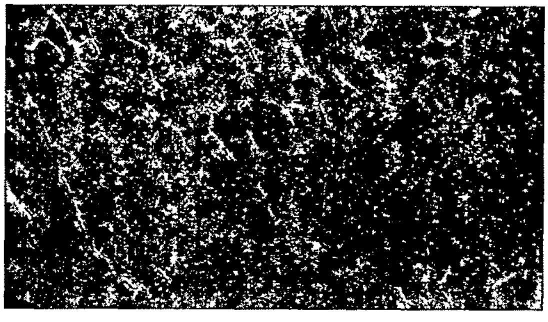

Fig. 2. Sub-cuticle membrane showing birefringent scale marks (phase-contrast micrograph in polarized light, × 175)

It is evident that this treatment dissolves the cortex and the exocuticle and will dissolve some, if not all, of the endocuticle. The *Zwischenmembran* and the epicuticle appear to be completely unaffected.

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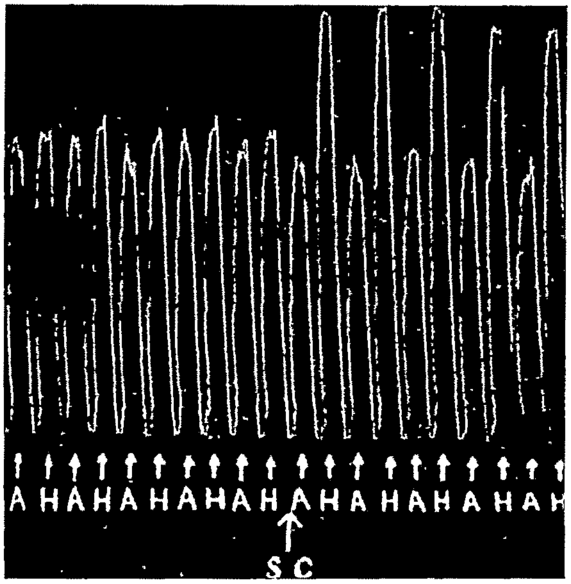
Potentiation of the Action of Histamine by Semicarbazide

ZELLER[1] has shown that semicarbazide inhibits histaminase. We have found that this substance, added to Tyrode solution, potentiates the action of histamine on the guinea pig's ileum. The lowest concentration at which semicarbazide clearly potentiates histamine is of the order of 10^{-9}. The optimum concentration is approximately 10^{-6}, when the size of the histamine contractions may be doubled. Very high concentrations depress the effects of histamine. Potentiation is rapidly established and readily reversible. The accompanying record shows that semicarbazide selectively potentiates histamine, but has no similar effect on acetylcholine. Semicarbazide alone produces no contraction of the ileum, and the potentiation is probably due to inhibition of histaminase. Eserine, which inhibits cholinesterase, potentiates the effect of acetylcholine on the ileum much more than that of histamine. Certain other inhibitors of histaminase also potentiate histamine. The most active compound hitherto found is 2-methyl-5-amino-methyl-6-amino-pyrimidine (B_1 pyrimidine) which we have obtained through the kindness of Dr. Bergel, of Roche Products, Ltd. This compound potentiates histamine in a concentration of 2×10^{-10}.

The intact isolated diaphragm of the rat destroys histamine when immersed in a solution containing the drug. If the outside concentration is similar to the concentration of histamine within the tissue, the amount of histamine in solution destroyed within 2–3 hr. is equivalent to that contained within the tissue. The normal tissue histamine is not destroyed under these conditions, being apparently not available to the enzyme which destroys the histamine in solution. Semicarbazide (10^{-3}) completely inhibits the destruction of histamine by the isolated diaphragm.

It has been previously shown that D-tubocurarine potentiates the effect of histamine on the ileum[2]. We



Contractions of the isolated guinea pig ileum with constant submaximal doses of histamine (*H*) and acetylcholine (*A*) added alternately Addition of semicarbazide (*SC*) to the bath fluid (concentration, 10^{-6}) potentiates the effects of histamine but not those of acetylcholine

have found that this potentiation only occurs if the D-tubocurarine is injected together with, or only shortly before, the histamine, and not if it has been in contact with the tissue for some time The mechanism of potentiation in this case is probably different from that of semicarbazide, and appears to be due to a release of histamine from the tissue

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Action of Thrombin in the Clotting of Fibrinogen

In spite of much literature on the clotting of blood, the exact mechanism of the final event, the mode of transformation of soluble fibrinogen to insoluble fibrin by the action of thrombin, remains unknown The concept of thrombin as a hydrolytic or proteolytic enzyme[1,2] has fallen into disfavour[3], and in recent years other plausible but unproved mechanisms have been proposed[4-6] In a study[7] of the proteins of the keratin–myosin–fibrinogen group by end-group assay with fluorodinitrobenzene[8], only small amounts of terminal amino-groups could be detected in fibrinogen, although the amounts were not sufficiently small to conclude, as in the case of myosin and tropomyosin, that the molecule is constructed of *cyclo*-peptide units The action of purified thrombin, however, results consistently in the appearance of amino-terminal residues of glycine, and whatever the ensuing mechanism, we believe that the fundamental enzymic step in the transformation of fibrinogen to fibrin is associated first with the appearance of these groups This action of thrombin, which tentatively may be considered as a very specific proteolysis, was discovered independently in Cambridge and in Leeds, and for this reason the relevant observations are reported jointly.

Cambridge Fibrinogen prepared from ox blood by salting out with phosphate buffer[9] and reprecipitating three to four times was found to be 90–95 per cent clottable and to contain approximately one terminal mole of tyrosine and one of glutamic acid in 250,000 gm. of protein[7], terminal residues of glycine were absent or negligible After clotting, the purest samples contained one terminal mole of glycine in about 100,000 gm of protein, which is of the order of five groups per mole of fibrinogen Some samples of doubtful purity have contained rather less, but in every sample of fibrin examined terminal residues of glycine were detected The action of thrombin seems specific for fibrinogen, since the incubation of proteins such as ovalbumin and myosin with the enzyme does not result in the liberation of new terminal groups The objection may be raised that amino-groups of glycine are actually present in fibrinogen but are unreactive, the action of thrombin being to reveal them by denaturing the protein This view is not supported either by the study of a denatured fibrinogen or by the application of treatments which generally enhance the reactivity of amino-groups[10]

Leeds A three-fold approach to the problem was made

(1) In order to make equal allowance for possible impurities, experiments in parallel were undertaken with purified ox fibrinogen and with the whole fibrin-plus-supernatant system obtained from it Clotting was carried out with Hoffmann–La Roche thrombin, or Prof Seeger's purest thrombin, kindly supplied by him, and in several experiments the clotting times were short and sometimes at 0° C, so as to lessen the possibility of non-specific hydrolysis The fibrin was found always to contain considerable numbers of amino-terminal groups of glycine, whereas none, or very few, was found in fibrinogen

(2) An attempt was made to isolate fibrin from any unchanged fibrinogen and from occlusions in the clot network by use of its solubility in urea[11] The clot was dissolved in a 30 per cent (w/v) urea solution, from which the fibrin was then precipitated by the addition of physiological saline, and washed thoroughly with saline and water The results with this material, considered to be pure fibrin, indicated approximately one terminal glycine per 140,000 gm of fibrin No other end-groups could be detected in appreciable amount, though glutamic acid was found at about one-tenth the glycine concentration, and occasionally still smaller quantities of serine and aspartic acid

(3) Since there is no adequate criterion of purity for fibrinogen, several methods of purification were tried, and in all cases the clottability of the final product exceeded 90 per cent The different preparations were then examined for α-amino groups, but, as mentioned above, no glycine end-groups (or only variable traces) could be found, and such positive indications as were observed may be ascribed to impurities or traces of fibrin Other terminal amino-acids were detected, however, including aspartic acid, glutamic acid and serine, but whether these are derived from fibrinogen or from impurities is not yet decided

Further evidence from the experiments as a whole suggests that during the course of clotting the number of glycine end-groups liberated can be used as an estimate of the amount of fibrin in the system

Our thanks are due to Prof W T Astbury for his interest and the benefit of discussions One of us (F R B) is indebted to the Medical Research Council for a grant

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Effect of High Concentration of Phosphorus-32 on Growth of the Potato

Studies of the use of phosphorus-32 for the production of somatic mutations in the potato require a knowledge of the amount of active material which, as part of the nutrient solution, would produce toxic effects at the growing points Further, the concentration of phosphorus-32 in the growing point must be known if an estimate is to be made of the radiation dose received A knowledge of the dose received is essential in order to make comparisons of the effects produced with those resulting from similar doses of other types of ionizing radiation In this communication, experiments with phosphorus-32 on three varieties of potato (Gladstone, Edzell Blue and Arran Pilot) are described

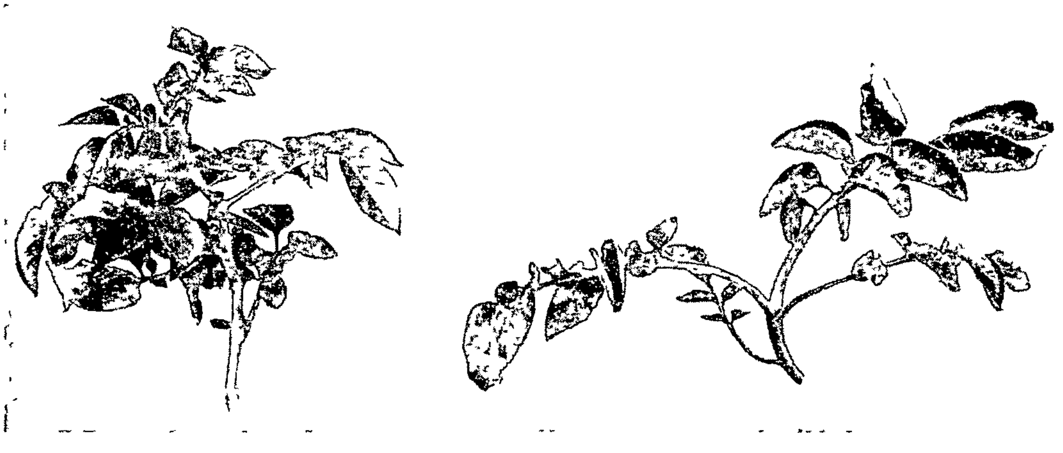
The potato is characterized by variation in the form and development of the individual according to the environment of the parent plant and the nature and size of the piece of tissue used in propagation The following method has been adopted so that the variation might be minimized and the residue analysed Individual sprouts obtained from the chitted daughter tubers of six plants of each of the three varieties were planted in 800 gm of acid-washed sand contained in waxed pots The moisture content was 50 c c Some 960 rooted sprouts were obtained, which enabled any somatic variation, physiological or genetical, to be analysed

No prior observations appear to have been reported on the toxic levels of phosphorus-32 in plants (that is, levels at which whole organs were killed as distinct from levels at which only the physiology of the plant was disturbed[1]) Two activity-levels were therefore employed Amounts of 10 μC. and 100 μC of phosphorus-32 per plant were given to separate batches of sprouts after they had been in sand for a week The amounts were dispensed in 10 c c of a 0 002 molar solution of disodium hydrogen phosphate At the time of potting the sprouts had been given a complete nutrient starter solution in which the normal phosphate-level was halved All nutrient was thoroughly leached from the pots twenty-four hours before treatment After treatment, the sprouts remained in the sand for a fortnight, during which a phosphate-free nutrient solution was given twice The plants were then removed and potted singly into compost after washing the roots At this stage there was no observable difference between the control plants and those treated at the 10-μC level, but approximately 1 per cent of the plants treated at the higher level were showing abnormal growing points The abnormalities were not sufficiently distinct to score at this time

Samples of the batch treated with 100 μC of phosphorus-32 taken at the end of the treatment period were analysed by wet digestion and the solutions counted in a liquid counter The results of these measurements of the average concentration and total activity of phosphorus-32 in each of the three varieties are given in Table 1

The variations in the measurement of different plants of the same variety are so great that the only varietal difference of possible significance apparent from the table is the greater concentration of phosphorus-32 in the Gladstone variety The activities have been referred to the initial treatment-time , but it should be noted that the weight of the plants at this time was smaller than at the time of measurement The average level of concentration during the first fortnight is therefore likely to be somewhat higher than is indicated by Table 1

In each case the growing point was dissected from the plant and the concentration of phosphorus-32 in it



Potato variety Gladstone, showing the difference between (left) normal and (right) blind shoots from 100-μC treatment, ½ natural size

Table 1 UPTAKE OF PHOSPHOROUS-32 AFTER TREATMENT WITH 100 μC

Variety	Total activity (μC)	Initial concentration (μC /gm)	Residue in sand (μC per pot)
Gladstone	23 7 ± 4 5	1 78 ± 0 20	4 5
Edzell Blue	21 4 ± 1 5	1 23 ± 0 18	4 5
Arran Pilot	17 5 ± 4 2	1 18 ± 0 11	8 0

Time-table Sprouts potted in sand, 19 5 50 , treated with 100 μC phosphorus-32, 30 5 50 , samples taken for analysis, 12 6 50

determined separately This concentration was found to be approximately six times greater than the average concentration of phosphorus-32 in the whole plant Again there appeared to be no significant difference between the three varieties

An estimate of the radiation dose received by the growing point may be made in the following manner It is well known[2,3] that for media of extent greater than twice the range of the beta-particles (that is, for phosphorus-32, thicknesses greater than about 1 cm) the dose throughout a tissue medium is about 800 r for a concentration of 1 μC /gm of phosphorus-32 completely destroyed This dose falls, near the edges of the medium, to a value at the surface of one-half the maximum dose If the medium is less thick than twice the range of the beta-particles, the maximum dose at its centre is less than that calculated above and varies in a known manner[4] The tissue, including leaf initials, surrounding the growing point was found to have an average thickness of about 0 4 cm , for which the maximum dose at the centre of the growing point would be[4] 680 r for 1 μC /gm of phosphorus-32 completely destroyed Assuming an average concentration of 1 5 μC /gm per plant (see Table 1) and a ratio of six times for the growing point (that is, 9 μC /gm), the total dose received by the growing point would be 6,000 r The range of variation is probably from about 4,000 r to 8,000 r It should be noted that since the half-life of phosphorus-32 is 14 3 days, half the calculated dose will be received in the first fortnight It may well be that the dose in this fortnight is a more significant quantity than the total dose, for in the calculation of the latter it is assumed that the concentration of phosphorus-32 remains unaffected by the subsequent conditions of growth

When the plants had developed a satisfactory root system in compost, they were set out in the field and allowed to grow to maturity By the end of July (that is, two months after treatment) several abnormalities were visible in the treated plants These abnormalities included increased fleshiness of the leaves, loss of secondary leaflets, and increased branching compared with normal plants The most striking difference was, however, the appearance of blind plants in which the main shoot terminated in three leaves surrounding an aborted growing point The term 'blind' is adopted as the appearance is very similar to blindness in cauliflowers This condition is illustrated in the photograph, and the frequency with which it occurred is shown in Table 2 In normal plants the growing point is still viable when the rest of the plant is yellowing at maturity or has terminated in a flower truss

Table 2 PERCENTAGE OF BLIND PLANTS

Variety	Control	10-μC treatment	100-μC treatment
Gladstone	0 0	10 9 ± 4 6	68 0 ± 7 3
Edzell Blue	0 0	0 0	41 9 ± 4 3
Arran Pilot	0 0	0 0	51 5 ± 6 4

From Table 2 it would appear that varietal differences in resistance to damage probably occur, although to what extent the production of blind plants is dependent on the uptake of phosphorus-32 is not certain from these experiments

These experiments show, however, that about 100 μC of phosphorus-32 must be administered to potatoes in this fashion in order to produce observable effects Of this 100 μC , about 20 per cent appears to be taken up by the potato plant under these conditions The concentration of phosphorus-32 in the growing point appears to be about six times that of the average concentration-level in the plant, and doses of the order of 3,000 r are received by the growing point in the first fortnight following treatment with 100 μC of phosphorus-32

We wish to acknowledge our indebtedness to Prof W V Mayneord for his helpful criticism

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Antitumourigenic Action of Steroids as an 'Independent' Faculty of these Compounds

As the power of steroids to prevent œstrogen-induced abdominal fibroids decreases with their diminishing progestational activity (progesterone → deoxycorticosterone → testosterone), we assumed, in an earlier phase of our work, that antifibromatogenic activity is correlated with the progestational one[1] Whereas the finding that the non-progestational Δ^{16}-dehydroprogesterone was not antifibromatogenic seemed to substantiate this assumption, subsequent statements of ours were contrary to it It has long been known that substitutions at C_{17} considerably increase the progestational activity of testosterone[2] , however, when ethinyl-, ethyl- and vinyl-testosterone were tried in our work with fibroids, they were found to be not more, and often even less, antifibromatogenic than testosterone[3,4] Similarly, there was no correlation between androgenic and antifibromatogenic activities Neither was there any correlation between cortical and antifibromatogenic activities Pregnenolone-3-acetate is much inferior to 21-acetoxypregnenolone in maintaining alive the suprarenalectomized guinea pig[5] , however, very large quantities of the former prevented the formation of fibroids, whereas this was not the case with similar quantities of the latter[6] Thus we reached the conclusion that antifibromatogenic activity is a faculty *per se*, not a sequel of any known, or classical, physiological action of the respective steroids[4,7] It is not 'subordinate' to progestational action , it is an 'independent' action, to use Selye's[8] terminology

On the other hand, it must be pointed out that all antifibromatogenic steroids are 3-keto compounds[1] Pregnenolone-3-acetate is the only compound with OH at C_3 which shows antifibromatogenic activity, and then only when more than 30–50 times the progesterone threshold is given[6].

In the meantime, Masson and Selye stated that methyl-androstanediol and especially methyl- and ethinyl-Δ^5-androstenediol are progestational; their activity is not inferior, if not superior, to that of, for example, methyldihydrotestosterone[9]. In this connexion the androstanediol and androstenediol derivatives are exceptional among steroids with OH at C_3. We believed that similar compounds should offer an excellent opportunity of examining the question whether acquisition of progestational action would mean also acquisition of antifibromatogenic powers. The non-substituted androstenediol is without, or almost without, progestational action (ref. 10, comp. No. 13) and it is also without antifibromatogenic action[11] (see also ref. 12, p. 138, comp. No. 20). Will antifibromatogenic action be acquired by this compound by a substitution at C_{17}, as progestational action is ?

Experiments. The trials were made in the usual way. Tablets of α-œstradiol were implanted beneath the skin of castrated female guinea pigs; tablets of ethinyl-androstenediol (m.p. 243°) or methyldihydrotestosterone (m.p. 191°) (melting points determined by Dr. F. Fuenzalida, biochemist of this Department) were implanted on the other side of the same animal. Absorption of the former is very slow; only 0·6 ± 0·06 µgm. per day was absorbed per 1 sq. mm. of a tablet, as against 2·7 ± 0·2 µgm. of the latter. One to six tablets had to be implanted so as to obtain a convenient range of absorption of ethinyl-androstenediol in a group of twenty animals. Results with ethinyl-androstenediol and œstradiol were compared with those in a group of eight animals with œstradiol only, and to a group of twenty-four which received methyldihydrotestosterone and œstradiol. Classification of the fibrous tumour effect was made in arbitrary 'units', according to rules followed for some years in our work[13-16].

With œstradiol alone (average absorption per day 4 µgm.) an average fibrous tumour effect of 3·8 was obtained. With the simultaneous absorption of methyldihydrotestosterone, this figure decreased parallel with the quantity absorbed per day. The antifibromatogenic action of methyldihydrotestosterone became evident with an average dose of 103 µgm. per day; at 160 µgm. per day, the fibrous tumour effect was 1·7, decreasing to 0·8 when 223–453 µgm. per day were absorbed. On the other hand, no decrease of the fibrous tumour effect was obtained with ethinyl-androstenediol even when as much as 185–450 µgm. per day was absorbed simultaneously with œstradiol.

Increase of uterine weight due to œstradiol also was counteracted to a certain degree by methyldihydrotestosterone, especially with larger quantities of the latter. Genital bleeding, which occurs when œstradiol alone is given, was prevented by methyldihydrotestosterone but not by ethinyl-androstenediol.

The results with ethinyl-androstenediol are clear: acquisition of progestational power by a non-progestational steroid through a substitution at C_{17} does not mean acquisition of antifibromatogenic activity. Two compounds such as ethinyl-androstenediol and methyldihydrotestosterone, which are equally progestational, differ entirely as to their antifibromatogenic activity. Our conclusion that antifibromatogenic action is an *independent* action of certain steroid compounds, preferably of a small group of 3-ketosteroids, remains, therefore, unchanged.

Recently there has been in different countries much outstanding work with steroids in the treatment of benign and malignant tumours (see tabulated summary in ref. 12, pp. 161–162). For further progress in this field, it seems fundamental to realize that antitumourigenic action is not subordinated to any other known activity of steroid compounds.

Thanks are due to Drs. Carl Miescher and A. Wettstein, Ciba, Basle, Switzerland, for a generous supply of C_{17} derivatives; to Dr. E. Oppenheimer, Ciba Pharmaceutical Products, Summit, U.S.A., for α-œstradiol; and to the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation for aid given to the Department.

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Distribution of the Fatty Acids in the Liver Lipids of the Horse

In the liver lipids of animals which have so far been examined it has been found[1] that the phospholipids, as compared with the glycerides, contain less hexadecenoic acid but more stearic and highly unsaturated C_{20} and C_{22} acids, the latter being derived from dietary linoleic and linolenic acids[2]. Phospholipids, moreover, are generally regarded as selecting the more highly unsaturated acids from the diet[3].

The animals which have hitherto been used for the study of the fatty acid composition of the liver lipids have either been of the type which do not store linolenic acid (heterolipoid[4]) or else they have not had access to substantial amounts of this acid in the diet. We thought it of interest, therefore, to study the liver lipids of the horse, as this animal has been shown to store linolenic acid readily in the depot fats[5]. In the work now reported, the animals used had been fed solely on pasture, the main fatty constituent of which is linolenic acid.

The difference between the glycerides and phospholipids of the horse liver in respect of hexadecenoic, stearic and highly unsaturated $C_{20}-C_{22}$ acids are shown in Table 1 to conform with those previously found for other animals. The generalization, however,

Table 1 COMPOSITION OF THE LIVER LIPIDS OF THE HORSE

	Fatty acids (weight per cent)								
	Saturated				Unsaturated				
	C_{14}	C_{16}	C_{18}	C_{20}	C_{14}	C_{16}	C_{18}	C_{20}	C_{22}
Glycerides	1 7	25 2	5 3	—	1 6 (−2 0H)	8 3 (−2 0H)	52 8 (−4 5H)	3 4 (−6 2H)	1 7 (−6 0H)
Phospholipids	—	10 8	20 7	4 6	—	2 0 (−2 0H)	50 6 (−3 4H)	10 4 (−5 7H)	0 9 (−5 7H)

that the phospholipids select preferentially the more unsaturated acids is an over-simplification, as shown by the composition of the C_{18} unsaturated acids (cf Table 2), determined by the alkali isomerization technique of Hilditch, Morton and Riley[6]

Table 2 PERCENTAGE COMPOSITION OF THE C_{18} UNSATURATED ACIDS

	Octadecatrienoic (linolenic)	Octadecadienoic	Oleic (by difference)
Glycerides	47 8 (43 2)*	19 1	33 1
Phospholipids	8 1 (6 3)*	60 8	31 3

* Determined by the hexabromide method of White and Brown (ref 7)

It is apparent that the highly unsaturated linolenic acid, contrary to expectation, is present in much greater proportions in the glycerides of the horse liver than in the phospholipids of the horse liver, while octadecadienoic acid is present in much greater proportions in the phospholipids than in the glycerides, its concentration exceeding many times that found in the pasture lipids or in the depot fats of the horse

It is thus clear that the selectivity of the phospholipids, at least in the horse liver, is not for highly unsaturated acids in general, but for specific unsaturated acids irrespective of whether such acids have been derived by direct assimilation from the diet or by synthesis from other acids by the animal

Further investigations on the liver lipids of the horse and other animals are in progress, and it is intended to publish a full account elsewhere

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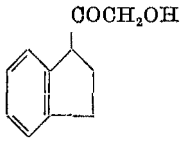
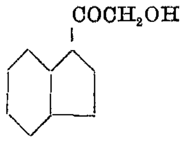
Synthetic Analogues of the Adrenal Cortical Hormones

THE problem of synthetic molecules likely to possess physiological properties similar to the adrenal cortical hormones is being investigated in these laboratories A number of such compounds have been prepared and examined, five of which have emerged showing significant activity. These compounds are indan-1-hydroxymethylketone (I), its fully saturated hexahydro analogue of unknown stereochemical orientation (probably *cis*) (II), 5-phenylindan-1-hydroxymethylketone (III $R = H$, OCH_3) and *p*-acetoxy-*p′*-(*w*-hydroxy)acetonyldiphenyl (IV)



I



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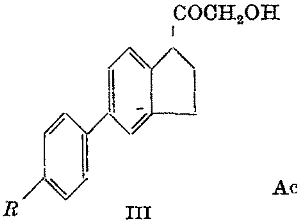
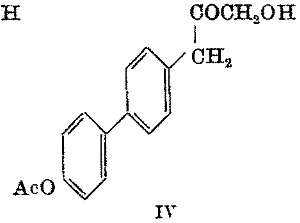


III



IV

These materials were synthesized from the corresponding carboxylic acids by the method of Steiger and Reichstein[1]

Table 1

Substance	Melting point	Analysis			
		Found		Required	
		C%	H%	C%	H%
(I)	b p 101–102°/0 1 mm pressure	75 8	6 5	75 1	6 8
(II)	99°	72 4	9 9	72 6	9 9
(III) $R = H$	36°	81 2	6 2	81 0	6 4
(III) $R = OCH_3$	84°	76 0	6 4	76 5	6 4
(IV)	93–94°	71 6	5 5	71 8	5 6

The life-prolongation tests were based on the survival under cold stress of bilaterally adrenalectomized young rats, the method being a modification of that due to Selye and Schenker[2] Groups of six to ten animals of average weight 40–55 gm were used at each dose-level of the substance under test, identical groups being used as controls, one group treated with DOCA and one left untreated The results of a number of such experiments on compounds I and II are summarized in Table 2 Preliminary results only are recorded for compounds (III) and (IV)

In every case the corresponding acetoxymethyl ketones proved completely inactive

Compounds (I) and (II) had no influence on the liver glycogen of adrenalectomized fasting mice, nor was any effect observed on the sodium/potassium metabolism in the rat

The biological tests are due to Prof G A H Buttle and Dr F J Dyer of the Pharmacological Department of this School (life-prolongation), Prof J Beattie and Mrs Herbert of the Royal College of Surgeons (glycogen), and Prof E C Dodds and Mrs

Table 2

Substance	No rats per group	Wt of substance giving same response as standard		M W	No moles cpd equivalent to 1 mole DOCA	Mean
		Subst (mgm)	Standard (DOCA) (mgm)			
(I)	5 5 5 8–10	3 3 3 1	0 33 0 375 0 33 0 087	176	17 10 17 21	16
(II) *cis* configuration ?	5 6 6 4	3 2 5 2 5	0 6 0 5 0 5 0 418	182	8 2 3 9 7 2 21 7	10 7
(III) R=H		1 25	0 25	252	6 6	
(III) R=OCH$_3$		1 25	0 5	282	2 9	
(IV)		1 25	0 5	282	2 9	

The error is of the order 100 ± 80 (P = 0 95)

Simpson (salt balance) of the Courtauld Institute of Biochemistry

Full details of the chemistry and pharmacology will be published elsewhere

We wish to acknowledge our indebtedness to the Medical Research Council for a grant, and one of us (D W M) is indebted to the University of London for the award of an I C I Fellowship

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Structure of Adenylthiomethylpentose

It has been shown in a previous communication[1] that the structure of adenylthiomethylpentose is 9′-(5-thiomethyl-ribofuranosyl)-adenine, based on periodate titration of adenylthiomethylpentose, thiosugar and thiopentitol, and from the result of the Boeseken test upon adenylthiomethylpentose We have now obtained further evidence for this structural formula using synthetic methods

Adenylthiomethylpentose gave a tritosyl derivative (m p 158–160°. Found N, 9 27 , calc for $C_{32}H_{33}O_9N_5S_4$ N, 9 21 per cent) on treatment with *p*-tosyl chloride in dry pyridine Since none of its tosyl residue was replaced by iodine on treatment with sodium iodide in acetone during 2 hr at 100°, it follows that there is no tosyl group at position 5 of the sugar portion

Condensation of adenylthiomethylpentose with acetone in the presence of zinc chloride gave mono-*iso*propylidene adenylthiomethylpentose (m p 143°. Found . N, 19 9 , calc for $C_{14}H_{19}O_3N_5S$ N, 20 7 per cent. Picrate, m p 175° Found N, 19 76, S, 5 8 , calc for $C_{14}H_{19}O_3N_5S\ C_6H_3N_3O_7$ N, 19 78, S, 5 66 per cent), from which the *iso*propylidene group was hydrolysed by dilute acid to give adenylthiomethylpentose again, though the yield was very poor

On the other hand, monoacetone adenosine, obtained by condensing with acetone in the presence of zinc chloride by the method of Levene and Tipson[2], was converted to 5-tosylmonoacetone adenosine (found N, 15 52 , calc for $C_{20}H_{23}O_6N_5S$ N, 15 18 per cent) by treating with *p*-tosyl chloride in dry pyridine at room temperature for 24 hr Dry tosyl monoacetone adenosine and dry sodium methyl mercaptan was dissolved in acetone and the solution heated in a sealed tube at 100° for 2 hr The reaction product (5-thiomethylmonoacetoneadenosine) after conversion into the picrate, which had a melting point of 172–174° (decomp) (found N, 19 3, S, 5 3 , calc for $C_{14}H_{19}O_3N_5S\ C_6H_3N_3O_7$ N, 19 7, S, 5 6 per cent), was compared with the monoacetone derivative of the natural compound, and no melting-point depression occurred when admixed with the picrate of monoacetone adenylthiomethylpentose

Also, from 5-tosyl-2,3-*iso*propylidene inosine[3] (m p 185°) 5-thiomethyl-2,3-*iso*propylidene inosine was obtained by heating with sodium methyl mercaptan in acetone The crude reaction product was converted into picrate (m p 102° (decomp) , found N, 16 4 , calc for $C_{14}H_{18}O_4N_4S\ C_6H_3N_3O_7$ N, 17 2 per cent)

Treating adenylthiomethylpentose with nitrous acid gave hypoxanthinylthiomethylpentose (m p 221°) as described by Kuhn and Henkel[4], which yielded a monoacetone derivative (m p 85° (decomp)) on condensing with acetone in the presence of zinc chloride The picrate of the latter had a melting point of 105° (decomp) (found N, 16 75 , calc for $C_{14}H_{18}O_4N_4S\ C_6H_3N_3O_7$ N, 17 2 per cent), and showed no melting-point depression when admixed with the picrate of the monoacetone-derivative of 5-thiomethylinosine

This work was aided by a grant from the Scientific Research Fund of the Ministry of Education of Japan

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An Isomeric Benzylideneguanosine

Although various investigators[1] have prepared benzylideneguanosine, Michelson and Todd are the only ones who report a specific rotation as well as a melting point for this compound Recently it became desirable to prepare benzylideneguanosine in this laboratory Using the same general method described previously[1], we have obtained a benzylideneguanosine with a melting point in agreement with those already reported, but with a specific rotation which is quite different On the other hand, benzylideneadenosine has also been prepared and has been found to be identical in physical properties with the substance described by Michelson and Todd[1]

Anhydrous guanosine from yeast nucleic acid (m p 235° C decomp (all melting points are uncorrected), $[\alpha]_D^{26}$ $-$ 60 2° in 0 1 N sodium hydroxide*, c 3 05 , $[\alpha]_D^{21}$ $-$ 34 1° in dimethylformamide, c 0 122) was used as the starting material in the preparation of the benzylidene derivative

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* This specific rotation is for guanosine containing two molecules of water of crystallization , all other specific rotations given in this communication are calculated on an anhydrous basis

Crude benzylideneguanosine was isolated in 74 per cent yield (m p 282–287° C decomp , $[\alpha]_D^{22}$ − 88° in 0 1 *N* sodium hydroxide, *c* 0 62) Contrary to the experience of others¹, repeated recrystallization from 70 per cent ethanol failed to yield an analytically pure product On recrystallization from aqueous 'Cellosolve', however, one-third of the crude material was recovered as a crystalline product (rosettes of flat leaves) Recrystallization of this material from 70 per cent ethanol left the melting point and specific rotation unchanged The properties of this sample are as follows melting point, 301–2° C (decomp), $[\alpha]_D^{25}$ − 73 2° in dimethylformamide, *c* 1 413, $[\alpha]_D^{25}$ − 72 5° in pyridine, *c* 0 588 (a nearly saturated solution of our benzylideneguanosine in pyridine, Michelson and Todd's results indicate that their benzylideneguanosine is much more soluble in pyridine), $[\alpha]_D^{25}$ − 79 8° in 0 1 *N* sodium hydroxide, *c* 0 602 The analytical results are, furthermore, in good agreement with the values calculated for benzylideneguanosine (found, in material dried to constant weight *in vacuo* at 110° C, 54 94, H, 4 52, N, 18 91, calculated for $C_{17}H_{17}O_5N_5$ C, 54 98, H, 4 62, N, 18 86 per cent)

The above data, in conjunction with those of Michelson and Todd¹, indicate clearly the existence of benzylideneguanosine isomers Although the nature of this isomerism is not at present understood, several explanations are possible (1) the isomerism may be due to the substitution of the benzylidene group in different positions on the nucleoside, (2) the isomerism may be due to the new asymmetric centre introduced by the substitution of a benzylidene group in guanosine Further experiments are in progress to determine the structures of the isomers

This research was supported in part by the United States Atomic Energy Commission

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Arylamine-N-glycosides

THE study of amine-N-glycosides has been stimulated in recent years by the occurrence of this type f compound in nucleic acids and in certain conzymes The present position is that, whereas the ucleosides are generally accepted as being N-uranosides, the structures of the simpler compounds f this type, such as aniline-N-glucoside (glucose nilide), have not yet been firmly established¹

Aniline condenses with D-ribose under different onditions to give two distinct crystalline aniline-N-D-ribosides, one of which, it has been suggested, s a pyranoside, whereas the ther is a furanoside² However, as has already been ointed out¹, further evidence s necessary before the structures assigned to these comounds can be accepted We ave now shown that when niline reacts with ribose in lcoholic solution the isomer hich is obtained depends on the presence or absence of water By heating aniline with ribose in anhydrous ethanol, we have invariably obtained isomer *A*, of melting point about 130° $[\alpha]_D^{15}$ + 186° (*c*, 0 8 in pyridine) If the reaction is carried out with moist ethanol there results isomer *B*, of melting point about 115°, $[\alpha]_D^{15}$ + 62° (*c*, 1 0 in pyridine) *A* is the furanoside of earlier workers²⁻⁴, and *B* their pyranoside Attempts to recrystallize *A* from moist ethanol give *B*, similarly, *B* is converted to *A* in dry ethanol Although there are some discrepancies in the specific rotations of the two compounds as determined by different workers (see accompanying table), it is clear that in methanol, at least, the specific rotations of the two compounds change to approximately the same final value, which does not lie between the individual values If the methanolic solution of constant specific rotation is allowed to evaporate to dryness in the laboratory atmosphere, the crystals deposited are *B* in every case

The simplest explanation of this behaviour is that each of the two compounds *A* and *B* is converted in solution into an equilibrium mixture of *A*, *B* and the acyclic, Schiff's base type of compound We have no evidence in support of the existence of this third form The contrast in behaviour between the stable O-glycosides and the labile N-glycosides is very striking This facile interchange of forms in solution apparently general for arylamine-N-glycosides, renders inapplicable most of the chemical methods normally used for elucidating structure The use of infra-red absorption spectra measurements appears promising, but has not yet been widely investigated⁴ It is noteworthy, however, that all the characterized derivatives prepared from arylamine-N-glycosides have the pyranose ring system For example, aniline-N-glucoside has been shown to yield, on acetylation, a mixture of α- and β-aniline-N-glucopyranoside tetra-acetates¹ After many experiments, we have now been able to methylate aniline-N-glucoside under mild conditions with dimethyl sulphate to obtain 2 3 4 6-tetramethyl β-aniline-N-glucopyranoside in rather low yield In addition, the two aniline-N-ribosides have been shown to give aniline-N-ribopyranoside tri-acetate²,³, and β-aniline-N-galactoside is acetylated to the pyranoside tetra-acetates⁴

Although in many cases two crystalline isomers of the arylamine-N-glycoside have been obtained, this is not invariably true Aniline-N-glucoside is known only as an amorphous solid, whereas *p*-toluidine-N-glucoside and aniline-N-galactoside have each been isolated in one crystalline form only, probably the β-pyranoside¹,⁵ By using anhydrous conditions for the preparation of N-glycosides, we have been successful, in certain cases, in obtaining a new isomer The case of *p*-toluidine-N-glucoside illustrates this The only isomer previously known has melting point 117–118°, $[\alpha]_D$ − 101 → −46° (*c*, 0 5 in methanol), whereas the compound obtained using anhydrous ethanol has melting point 135–136°,

	[α]*D* of *A*		[α]*D* of *B*	
Ref	In methanol	In pyridine	In methanol	In pyridine
2	Not given	+ 176 5° → + 156 6°	Not given	+ 63 4° → + 48 6°
3	Not given	+ 180° (dry solvent) + 180° → + 161° (moist solvent)	Not given	+ 60° (dry solvent) + 60° → + 48 4° (moist solvent)
4	+ 135° → + 12°	+ 182° → + 52 3°	+ 23° → + 13°	+ 62° → + 50°
Present authors	+ 171° → + 14° + 135° → + 14°	+ 186°	+ 24° → + 10°	+ 62°

$[\alpha]_D + 209 \rightarrow -45°$ (*c*, 0.6 in methanol), and is probably α-*p*-toluidine-N-glucopyranoside. In the same way we have obtained evidence for the existence of an aniline-N-galactoside distinct from the previously known one. It appears to be general, where two isomers have been obtained from the same sugar and amine, that their specific rotations in methanol change to the same final equilibrium value.

We acknowledge our indebtedness to Roche Products, Ltd., for a generous gift of ribose, to the Chemical Society for a grant from the Research Fund, and to Merioneth County Education Committee for a scholarship awarded to one of us (G. P. E.).

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The 'Turn Over' Transition of Suberic Acid

A lattice transition which is not induced by nuclei or boundaries but takes place simultaneously in the whole of a crystal by the jump of a whole lattice plane is termed 'turn over' (*Umklappen*). Such transitions are observed with certain metals (cobalt, thallium) and especially in the austenite-martensite transition. When, in 1941 in this laboratory[1], the phenomenon was discovered for the first time with an inorganic salt (potassium dichromate), we were informed by Prof. L. Kofler (Innsbruck) that a similar 'flashlike' transition can be observed with suberic acid crystals. The features of this 'turn over', as we have observed it, are described here.

Sufficiently pure suberic acid, molten between two cover glasses in a Leitz heating-stage of a polarizing microscope, crystallizes on cooling at 143° C. in the form shown schematically in Fig. 1 (right). On further cooling, at 90° C., the crystallites, every one separately, suddenly split up into a series of smaller crystallites, separated by striæ perpendicular to the longest dimension of the original crystal, as shown in Fig. 1 (left). The striated form remains unchanged down to room temperature. On reheating, at 90° C., the striæ disappear, again simultaneously and independently over the whole area of an original crystallite or a large part of it, and, by a number of such flashes, the high-temperature picture is restored. This can be repeated many times. This transition of the free acid does not occur with the amide, the ammonium or sodium salt.

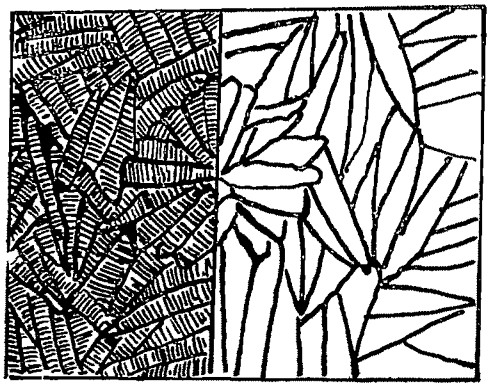
Fig. 1

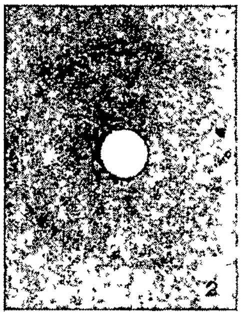

Fig. 2

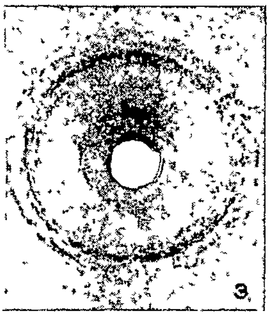

Fig. 3

X-ray photographs were taken both of the high- and low-temperature forms, with iron $K\alpha$ radiation and a camera diameter of 57.3 mm. Liquid suberic acid was sucked into a piece of Mark capillary surrounding an electrically heated axial platinum wire. The whole was rotated through 120° about the camera axis. The temperature-voltage characteristics of the arrangement being known, it was possible to keep the preparation at the temperature desired or to change its temperature quickly. The high-temperature form, crystallized from the melt between 143° and 90° C., in this arrangement forms large and orientated crystals so that only a few spots appeared on the film. In order to obtain measurable rings, it was necessary to melt the acid for 15 sec. and allow it to crystallize anew above 90° C. once a minute for one hour. Figs. 2 and 3 were obtained from the high- and low-temperature form respectively.

Suberic acid is reported[2] to crystallize in the monoclinic system with $a = 10.12$ A., $b = 5.06$ A., $c = 12.58$ A., $\beta = 135°$, two molecules lying parallel to *c* in a base-centred cell. The diagrams, after subtraction of faint platinum lines, were indexed on this basis, and indices, spacings and estimated intensities are given in the accompanying table for the calculated diagram, for the cold- and the hot-form.

X-Ray Spacings (*d*) and Intensities (*I*)

hkl	*d* (calc.)	*d* (cold)	*I* (cold)	*d* (hot)	*I* (hot)
001	8.88	8.55	5	—	—
002 011	4.44	4.33	3	—	—
110	4.13	4.06	5	4.30	5
200	3.58	3.73	2	3.80	5
012	3.33	3.50	5	—	—
003	2.96	3.04	2	—	—
210	2.92	2.93	4	3.02	3
120 300	2.40	2.25	2	2.34	1
202	2.14	2.16	2	—	—
221	1.85	1.84	2	—	—

The cold form corresponds to the calculation without systematic deviations. As for the hot form, it is characteristic that only the interferences *hk*0 appear. This can be seen directly in Fig. 2 where, at the position of the inner circle (001) of Fig. 3, only an 'amorphous ring' appears. This ring appears equally with liquid suberic acid and can be ascribed to the liquid state being present during a quarter of the exposure. Hence, the high-temperature modification shows lattice order only in the directions perpendicular to the *c*-axis, whereas in the *c*-direction it is 'liquid'.

For the cold form, the smaller angle at the centring chain in the plane perpendicular to c is calculated to be 71°. On transition to the hot form, within the accuracy of the few lines available, calculation indicates a dilatation of 4.5 per cent in the a-direction and a contraction of 3 per cent in the b-direction. This makes the above-mentioned angle decrease to 67°. The same tendency of the angle to approach 60° (hexagonal arrangement) has been observed by A. Muller[3] on heating long-chain paraffins, and is explained by increasing rotation of the carbon chains about the c-axis. If we assume now that at the transition point this rotation begins to cover the full circle, it will eliminate in the hot form a considerable part of the dipole forces between the carboxyl groups of neighbouring parallel chains which, in the cold form, hold these groups in one plane. Thus, a parallel shift of the chains into disordered positions may be made possible.

As for the question why it is exactly that suberic acid shows this interesting type of transition, it is perhaps of interest that the high-temperature modification forms mixed crystals with adipic acid but not with sebacic acid, and that (001) is very weak in the former and strong in the latter. Perhaps the transition point, sharp or not, is situated below room temperature for adipic and above the melting point for sebacic acid, and observable only with suberic acid (only these two acids are comparable, as those with odd numbers of carbon atoms have double elementary cells, see ref. 2).

A flashlike transition has been described also by C. Weygand[4] for "Tridekansaure"; however, we were unable to verify it, either with tridecylic (tridecanoic) or with myristic (tetradecanoic) acid.

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Molecular Interaction and its Relation to the Formation of Sodium Dodecylsulphate–Cetyltrimethylammonium Bromide Complex

IT is well known that anionic and cationic detergents are not compatible in aqueous phase when they are present in equimolecular amounts. Compatibility is only observed for certain ratios which depend upon the molecular structure of both components. Precipitation of anionic by cationic detergents present in equimolar amounts constitutes the basis of one of the methods used for their estimation. The work carried out by Salton and Alexander[1] has shown this method to be applicable for determining small amounts of such pure detergents.

When the reagents are not well purified, the above method of titration is no longer valid, due to traces of polar compounds such as long-chain alcohols which are known to interact with the detergent to form a molecular association. Relatively high amounts of hexyl or heptyl alcohol are needed to prevent the precipitation, whereas the presence of octyl or nonyl-alcohol in equimolecular ratio will inhibit the formation of sodium dodecylsulphate – cetyltrimethylammonium bromide complex. For example, an $M/300$ solution of these substances with octyl alcohol will be completely clear when these reagents are in the molecular ratio 1 : 1 : 1; in the absence of the alcohol a marked flocculation of the sodium dodecylsulphate – cetyltrimethylammonium bromide complex is observed. It is clear that the alcohol - sodium dodecylsulphate complex is competing with the sodium dodecylsulphate – cetyltrimethylammonium bromide association, and that as a result of the presence of the long-chain alcohols (C_8, C_9) the anionic detergent has lost certain of its properties. Schulman[2] has already shown that cholesterol will inhibit precipitation of sodium cetylsulphate by addition of silver nitrate. The results now obtained show that with octyl alcohol a strong molecular interaction occurs and demonstrate the existence of a 1 : 1 complex of sodium dodecylsulphate–octyl alcohol, a conclusion already reached by Matalon[3].

The inhibition of precipitation of anionic by cationic detergents appears then to be due to competition between two types of molecular interaction.

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Exchange of Carbon-13 Dioxide between Solid Carbonates and Gaseous Carbon Dioxide

IN connexion with a study of the reaction mechanism of the thermal decomposition of dolomite, we are investigating exchange between carbon-13 dioxide ($^{13}CO_2$) and solid carbonates at high temperatures. To our knowledge exchange reactions using isotopic tracers between gaseous and solid reactants have, so far, only been carried out[1,2] on oxides and oxygen-18.

Depending on temperature and partial pressure of carbon dioxide, dolomite can be decomposed either partially to $MgO + CaCO_3$ or completely to $MgO + CaO$. (Experiments on the isobaric thermal decomposition of dolomite at various pressures of carbon dioxide have been carried out simultaneously and will be published elsewhere.) In order to obtain further information on the reaction mechanism involved, a detailed investigation, particularly on the first stage of decomposition, was thought appropriate. In this case two questions immediately arise: (*a*) Is calcium carbonate primarily formed from the original dolomite lattice?—$CaMg(CO_3)_2 \rightarrow MgO + CaCO_3 + CO_2$. (*b*) Is dolomite first decomposed to magnesium and calcium oxides, when, under sufficient partial pressure of carbon dioxide, the latter then recombines to form calcium carbonate?—(i) $CaMg(CO_3)_2 \rightarrow MgO + CO_2 + CaO + CO_2$; (ii) $CaO + CO_2 \rightarrow CaCO_3$, It was hoped to distinguish between these two mechanisms by studying the thermal decomposition of dolomite in presence of labelled carbon dioxide $^{13}CO_2$ generated from barium carbonate labelled with 62 per cent carbon-13 was used for experiments, and isotopic abundance ratios were measured on a Consolidated-Nier mass-spectrometer, model 21-201, at an accelerating voltage of 1,160 volts and a magnetic field-strength of 2,200 gauss A resolving power of 0 043 per cent was obtained and a peak height of 15 volts was used for the 44 peak

Practically chemically pure well-crystallized dolomite (Thornwood, New York) was used Finely ground material was spread in a thin layer on the walls of a quartz tube Generation of carbon-13 dioxide, degassing of solid carbonates, mixing of normal and labelled carbon dioxide and drawing off of samples were carried out under proper conditions on a high-vacuum system Care was taken to obviate 'memory' and contamination effects at all stages during experiments

In an initial series (I) (control experiments) dolomite was first decomposed to magnesium oxide plus calcium carbonate at a temperature of 700° C and a pressure of carbon dioxide of about 400 mm These conditions were chosen from our experience with isobaric thermal decomposition experiments As a sequel to this, the solid reaction product was heated for one hour to the same temperature and under the same pressure of carbon dioxide, which, however, now contained approximately 20 per cent carbon-13 dioxide

In a second series (II) of experiments, thermal decomposition of dolomite was carried out in the presence of carbon-13 dioxide under identical conditions Initially a degree of exchange was obtained by the difference of carbon-13 content in samples of carbon dioxide gas taken before and after exchange Greater accuracy, however, was obtained by direct measurement of carbon-13 content of the carbon dioxide evolved when magnesium oxide plus calcium carbonate were completely decomposed after exchange at 700° C, evolved carbon dioxide being condensed with liquid oxygen

For comparison purposes a sample of calcite (Cherokee County, Kansas) was treated under corresponding experimental conditions with carbon-13 dioxide

Some of the results obtained are tabulated in Table 1

Table 1

Experiment	Weight of carbonate (mgm)	Total pressure of carbon dioxide at 700° C (mm)	Atomic per cent carbon-13			
			In reaction gas after exchange	In carbon dioxide evolved on complete decomposition	Calculated for complete exchange	Observed as percentage of complete exchange
Dolomite	100 0	400	1 24*	1 24*	—	—
Dolomite Series I	101 2 100 0	408 422	21 82 19 71	4 48 4 49	14 5 14 3	31 0 31 4
Dolomite Series II	99 4 98 0	395 403	21 24 21 20	5 67 5 72	14 9 14 7	38 1 39 0
Calcite	100 3	397	19 42†	2 80	10 3	27 2

* This shows that isotopic abundance of carbon-13 in normal and bound carbon dioxide is the same

† Percentage of carbon-13 before exchange was 21 56 From carbon-13 content after decomposition (2 80 per cent), carbon-13 content in the reaction gas after exchange can be calculated Calculated value 19 6 per cent, observed value 19 4 per cent

From the above results it is apparent that a considerable exchange occurs between solid carbonates and gaseous carbon dioxide The exchange in series II, where the dolomite was decomposed in the presence of carbon-13 dioxide, is definitely higher than in series I, where exchange occurred after decomposition to magnesium oxide plus calcium carbonate With natural calcite there is a distinct exchange which is, however, lower This is presumably due to the different subdivision of calcium carbonate and consequent difference in surface area available for exchange reaction

That exchange is a surface effect is an obvious conclusion, in so far as exchange would take place rather rapidly in the surface layer of the solid and then would proceed more slowly into the interior of the particles[2] To confirm this, the reaction product was completely decomposed after exchange as described This time, however, the condensate was collected as two or three successive fractions at the time intervals indicated below These fractions showed a decreasing content of carbon-13, indicating that the most enriched samples were obtained in the first gas evolved (see Table 2)

Table 2

Experiment	Weight of dolomite (mgm)	Total pressure of carbon dioxide at 700° C (mm)	Atomic per cent carbon-13			
			In reaction gas after exchange	In carbon dioxide evolved on complete decomposition of the reaction product MgO + $CaCO_3$ Fractions condensed from		
				0–5 min	5–15 min	15–35 min
Dolomite Series I	100 3 100 1	404 400	20 55 19 84	5 57 5 14	2 80 2 80	2 20 2 25
				0–15 min		
Dolomite Series II	99 6	385	21 74	5 66		4 01

The higher exchange in series II, which is well reproducible, can be readily explained by reaction mechanism *b*, assuming that calcium carbonate is regenerated by a reaction of primarily formed calcium oxide with carbon dioxide from the gas phase So far, however, it is not possible to exclude the alternative mechanism, namely, the primary formation of calcium carbonate from the original dolomite lattice In this case, higher exchange may be due to a higher reactivity of calcium carbonate during rearrangement of the lattice (Hedvall effect)

At the moment it is preferable to leave the question open and to discuss it further in conjunction with present X-ray investigations on thermally decomposed single crystals of dolomite

Experiments on rate of exchange at different temperatures and pressures are contemplated, and surface area measurements will be carried out in conjunction with these

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R A W Haul
L H Stein
National Chemical Research Laboratory,
J D Louw
National Physical Laboratory,
S A Council for Scientific and Industrial Research,
Pretoria
Sept 29

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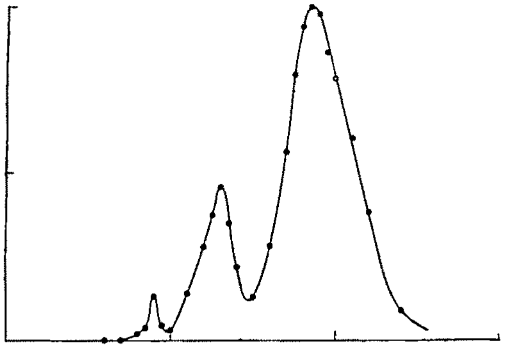
[1] Allen, J A, and Lauder, I, *Nature*, 164, 142 (1949)

[2] Houghton, G, and Winter, E R S, *Nature*, 164, 1130 (1949)

Radio Reflexions from a Column of Ionized Gas

A THEORETICAL discussion by Herlofson[1] shows that a narrow ionized column—such as a meteor trail—will be a particularly good reflector for radio waves of frequency ν if the electric vector in the waves is perpendicular to the axis of the column, and the electron density is approximately equal to $\frac{2\pi m}{e^2}\ \nu^2$ (Mr Herlofson informs me that his note in *The Observatory* is not correct , in particular, resonance will occur for values of ε near −1 instead of 0 A revised theory will be published elsewhere) In this case, even a column which is very narrow compared with a wave-length will. reflect as efficiently as a metal strip with a width comparable to a wave-length The strong reflexion is a resonance effect, and will be damped if the electron collision frequency is not small enough

This effect has been studied by measuring the reflexion of 30-cm radio waves from a mercury discharge in a tube with a diameter of 3 2 cm and a length of 80 cm This diameter was chosen because t is a small fraction of a wave-length and hence would show the resonance effect clearly In addition, the electron density as function of discharge current s known for a tube of this diameter from probe neasurements by Langmuir and Mott-Smith[2]



Amplitude of reflected wave as a function of discharge current (amp)

The radiation was supplied by a 10-W transmitter ith a Yagi aerial 1 5 metres away from the tube, nd the reflected signal was measured at the same istance from the tube by a similar aerial connected o a crystal detector The two aerials were separated y about 50 cm

Disturbing reflexions from the glass tube and the boratory walls were often comparable to the eflexion from the discharge , but they could be minated by repeated measurements with the discharge tube in different positions over a range of ne-fourth of a wave-length

The vapour pressure was kept independent of the scharge current by a powerful air blast which oled the tube walls to about 25° C Special precutions were taken to eliminate instabilities in the scharge current, which would have a marked fluence on the measurements

The accompanying graph is typical for the results tained From the data of Langmuir and Mottnith, resonance was expected to occur for a discharge current of about 0 8 amp The main peak is served at 0 93 amp The maximum power reflected from the discharge amounted to about 80 per cent of the power reflected from a metal strip half a wave-length wide

The existence of multiple resonance peaks had not been anticipated, and is not yet fully explained If the amplitude and phase of the reflected wave are plotted in the complex plane, three resonance loops appear It is noteworthy that the ratio between the discharge currents for successive maxima (and hence between the electron densities) is equal to $\sqrt{2}$ within the accuracy of measurement

If the aerials were turned 90° about their axes, so that the plane of polarization became parallel to the discharge tube, the amplitude of the reflected wave became unobservable for all values of the discharge current Similarly, any radiation in a direction 90° from the incident beam was masked by radiation reflected from the glass tube

In a preliminary investigation of the effect of electron collisions, the cooling air blast was removed. The rise of temperature increased the mercury vapour pressure by twenty times, and the amplitude of the resonance maximum fell to a small fraction of the amplitude at 25° C

Denno, Prime and Craggs[3] have recently reported a set of similar measurements with 3-cm radio waves , but since their tube diameters are equal to, or larger than, the wave-length, a comparison of their results with theory or with the present experiments is not easy

DAG ROMELL

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Oct 11

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[1] *Observatory*, 68, 230 (1948)

[2] *Gen Elec Rev* , 27, 762 (1924)

[3] *Proc Phys Soc* , B, 63, 726 (1950)

Single-Crystal Neutron Diffraction Analysis

IN the past five years, neutron diffraction analysis has been carried out with wide neutron beams and specimens of several cubic centimetres in volume, in order to obtain a manageable diffracted intensity Such an expedient has many disadvantages In the powder method it leads to bad resolution, and incoherent scattering in the sample produces a background which is sometimes larger than the significant counting-rate This is particularly serious for the study of hydrogenous substances, which give large disordered scattering, and it has been widely concluded that deuterium compounds must be used in their place -With single-crystal methods the limitation arises from the severe extinction of the neutron beam A single crystal suitable for structure analysis must in general have dimensions of about 1 mm [1]

A technique is now proposed which permits the use of a small single crystal in conjunction with a pile of only moderate neutron flux. It has the following advantages over prevailing methods the counting-rates are greater , the ratio of Bragg peak to background count is improved to the degree that many hydrogen-containing substances may be studied , and the use of a small single crystal means that structures of greater complexity may be attempted

To gain the necessary intensity, the incident radiation is not monochromatized, but comes straight from the pile (Fig 1) In these circumstances the collima-

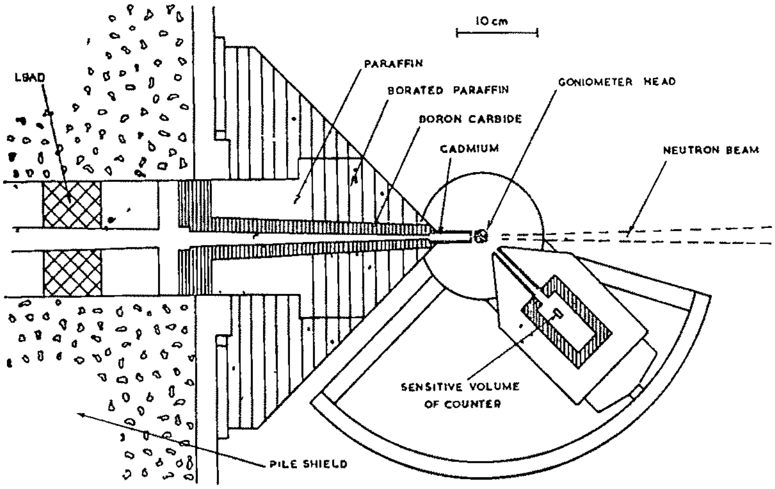
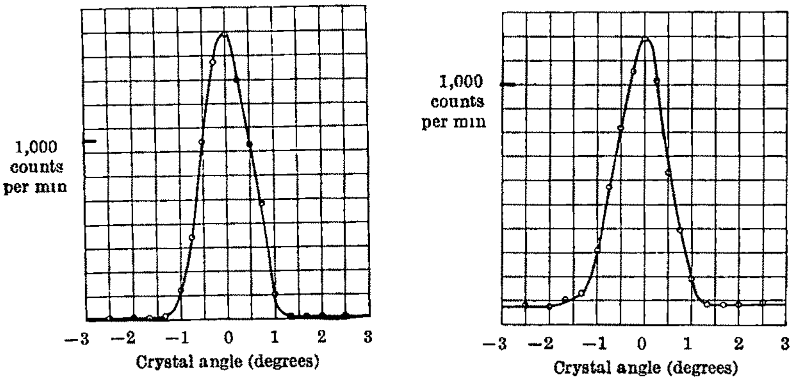


Fig 1 Neutron spectrometer

tion may be relaxed a geometrical gain of order 10 follows, since the solid angle from which diffracted neutrons are received at the counter is equal to the whole angular aperture of the collimator, instead of the small angular divergence of the beam reflected from a monochromating crystal In the apparatus shown, a pencil of diffracted radiation from a crystal of dimensions up to 2 mm may be intercepted, between Bragg angles of 13° and 59°, by a miniature counter[2] of efficiency 20 per cent

The 'integrated reflexion' to be measured in a structure analysis by this method is the peak counting-rate of the crystal rocking curve This is recorded for each reflexion of interest with an independent setting of both crystal and counter Over the range 3 2–0 85 A of d spacings, it can be so arranged that the mean wave-length taking part is always that which, independently of d, gives the maximum counting-rate The shape of the pile spectrum then discriminates against the higher- and lower-order reflexions from the plane examined

The confusion of all the orders of a given plane is, of course, the fundamental weakness of the method If the structure factors of all orders are the same, second-order impurity in the first-order beam is only about 3 per cent, but subharmonic impurities in the higher-order reflexions give rise to large corrections



(a) (b)

Fig 2 Rocking curves from (a) 1 3 mm^3 of sodium chloride, (200) plane, mean wave-length 1 48 A , and (b) 0 9 mm^3 of naphthalene, (001) plane, mean wave-length 3 30 A

Rocking curves from small crystals of sodium chloride and naphthalene are reproduced in Fig 2, and show intensities about ten times what is commonly obtained with a few cubic centi metres of powder The peak-to background ratio for sodium chloride may be compared with the published value of 3½ obtained by the powder method[3] The improvement, like the increase in intensity, is sufficiently in excess of expectation to suggest that the powder technique is capable of still further development Indeed, the intensity is enough to show that with projected high-flux piles, neutron diffraction analysis may be pursued with small crystals and monochromatic radiation in a manner altogether similar to that of modern X-ray crystallography

The curve for naphthalene indicates that information about hydrogenous organic structures is already within reach of the methods of neutron diffraction

R D Lowde

Atomic Energy Research Establishment,
Harwell.
Oct 2

[1] Bacon, G E , and Lowde, R D , *Acta Cryst*, 1, 303 (1948)

[2] Lowde, R D , *Rev Sci Instr*, 21, 835 (1950)

[3] Wollan, E O , and Shull, C G , *Phys Rev*, 73, 837 (1948)

Electrical Behaviour of Non-Aqueous Disperse Systems

The electrical conductivity of dispersions of conductive powders increases with time of rest afte shear according to the expression $\frac{dC/dt}{C} = Kt^n$ where n is an exponent between unity and 1 5, an K is equal to $\frac{dC/dt}{C}$ when time is unity The instantaneous conductivity, however, at any give state of rest after shear increases with increase i the A C or D C potential applied, attaining a asymptotic value at an E M F depending on th composition of the material Measurement of specifi inductive capacity of flocculate dispersions on an A C bridg presents great difficulties owin to the time involved in securin a balance and the constan growth of conductivity due t thixotropic effect Neverthele indications are shown of specifi inductive capacities of the ord of thousands when measured a 50 cycles, down to tens a 300,000 cycles

The specific inductive capacit of deflocculated systems of lo conductivity varies very litt with shear history when mea ured at 1 volt on an A C bridg At D C voltages up to 120 volt the specific inductive capacit as measured by a discharge the system, arranged as a condenser, through a ballistic galvanometer may be up to fourfold of those recorded at 1 volt A.C. Under these experimental conditions, flocculated systems comprising conducting particles exhibit values of specific inductive capacities reaching one or two thousand in spite of their high conductivities, and their slow rate of charge leakage is completely out of agreement with their known conductivities. Their specific inductive capacities also increase with the time under charge, often only attaining a maximum value in sixty seconds. Immediate remeasurement at a lower E.M.F. reproduces the specific inductive capacity originally shown at the lower voltage, so that the effects noted cannot be due to progressive flocculation or the more intense flocculating action induced by the electric field.

The high specific inductive capacities of flocculated dispersions must be connected in some manner with their superimposed conductivities, since dispersions of non-conductive powders show vanishingly small conductivities and low specific inductive capacities even when flocculated.

The high specific inductive capacities of flocculated systems cannot be ascribed entirely to the reduction of volume of the dielectric medium arising from the presence of the conducting particles, as deflocculated systems of similar volume concentrations show values little greater than that of the medium. Rather is it connected with the friction exhibited by the thin quasi-solid interstitial films of the medium, which give rigidity to the dispersion at concentrations of disperse phase well below those corresponding to critical packing.

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Oct. 12.

Effect of Ultrasonic Vibrations on Filariasis of the Cotton Rat (*Sigmodon hispidus*)

Small animals are very susceptible to minute doses of ultrasonic vibration. We have tried to influence the parasites of experimental infections with *Bilharzia Mansoni* in mice and *Litomosoides carinii* in cotton rats.

With *Bilharzia*, we observed no result at all. With *Litomosoides*, we noticed in two animals a very definite action on the microfilariæ very akin to the action we observed with S. Bettini[1] on *Filaria immitis* of the dog after injection of dibromosalicyl. Our apparatus worked on a frequency of 940 kc./s.

(1) Two cotton rats were held on their backs, and their chests wetted with water. The quartz vibrator was rubbed on the chest, on the first at 1.5 watts/cm.^{2}, on the second at 2 watts/cm.^{2}, for two minutes. In the first cotton rat, we noticed a decrease from 100 to 9 microfilariæ in ten fields during the first week, then they rose again to 40.

In the second cotton rat, microfilariæ were reduced from 30 to 4 during the first week. The animal suffered from diarrhœa and conjunctivitis, and died on the eighth day. The adult filariæ in it were alive, when the head was cut off, we noticed the effect mentioned earlier[1], namely, larvæ at the morula stage and some others more advanced, but granular and irregular.

(2) In a second experiment with three cotton rats, every animal received one daily treatment during three successive days with 1.5 watts/cm.^{2} during 1, 2 and 5 min., and a daily blood examination was made.

In the first rat, there was no action at all. In the second, the microfilariæ fell from 25 to 3 and remained so for several days. The third (fall from 30 to 1) died on the seventh day, with the same symptoms as those observed in the first experiment. Adult filariæ were alive, but the appearance of the uterine content, after decapitation, was the same as in the first experiment.

The fact that the two cotton rats which received the highest dose in the two experiments died with similar symptoms and showed similar action on the microfilariæ suggests that this was due to the ultrasonic vibrations, probably acting on the parasites. We were unfortunately unable to try other frequencies which might be more effective against the parasites and less harmful to the host.

Acknowledgment is due to Dr. A. Argamakoff, who kindly let us use an apparatus of his own construction.

E. Lagrange

Division Pharmaceutique,
Union Chimique Belge,
Brussels.
Oct. 6.

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[1] Bettini, S., and Lagrange, E., *Riv. di Parassitologia*, 8 (1947).

Angstrom Units, A. or Å.?

In 1907 the International Solar Union (later to be embodied in the International Astronomical Union) adopted I.A. for 'International angstrom'. In a report on series in line spectra prepared by A. Fowler for the Physical Society in 1922 the author says: "The unit of wavelength is the Ångstrom unit or 'angstrom', as it is now beginning to be called".

Since that time the use of the letter 'A' has been in general use among spectrographers, until just recently certain authors have begun to write 'Å' again. This would appear to be a retrograde step. It is certainly not in accord with the practice of most established workers in the subject.

In the well-known report on symbols issued by a joint committee of the Chemical, Faraday and Physical Societies in June 1937, the small capital roman 'A', with no accent, is the accepted symbol. It also occurs thus in the Spectrophotometric Terms and Symbols laid down by a Committee for the Society of Public Analysts in 1942. Picking up a few books at random, I find that in report No. 9 on Progress in Physics, 1942–43, C. H. Bamford uses 'A'. In the same publication R. W. B. Pearse, in a paper on "Spectra in the Night Sky", uses 'A', the same author in a recent Royal Society paper on the identification of molecular spectra again writes 'A'. As for American authors, Brode ("Chemical Spectroscopy"), Sawyer ("Experimental Spectroscopy") and most authoritative of all, George R. Harrison in his "Wavelength Tables", all use 'A'. Examples might be multiplied indefinitely, while among the hundreds of English industrial spectrochemical analysts, the practice of writing 'A' is, I believe, universal.

F. Twyman

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 12

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment London, W C 2), at 5 30 p m —Discussion on "Inventor, Engineer and Manager" (to be opened by Mr P P Eckersley)

Manchester Literary and Philosophical Society (at the University, Manchester), at 5 30 p m —Prof S C Harland, F R S "The Evolutionary History of Cotton" (Percival Lecture)

Tuesday, February 13

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine Keppel Street, London, W C 1), at 1 p m —Mr David Cox "The Organization of Repetitive Tasks"

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W 8), at 5 p m —Scientific Papers

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Mr A Hine "The Inductor Compass"

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr C W Bonniksen "The Manufacture of Alginates"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Mr H A Sieveking "Some Aspects of the Development of Hydro electric Power" * (Further Lectures on February 20, 27 and March 6)

Royal Aeronautical Society (at 4 Hamilton Place, London, S W 1), at 7 p m —Mr D J Lambert "Derivation and Estimation of Aerodynamic Loads for Stressing Purposes"

Wednesday, February 14

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Dr D McKie '1851–1951, a Century of British Science"

University of London (at Westfield College, Kidderpore Avenue, London, N W 3), at 5 15 p m —Prof E N da C Andrade, F R S "Science in the 17th Century" *

Institute of Petroleum (at Manson House, 26 Portland Place, London, W 1), at 5 30 p m —Mr T C G Thorpe "Petroleum Waxes"

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 30 p m —Mr H Campion "Recent Developments in Economic Statistics"

Institution of Electrical Engineers (at Central Hall, Westminster, London, S W 1), at 6 30 p m —Mr L J Davies "Lamps and Lighting—a Record of Industrial Research" (Faraday Lecture)

Institution of Works Managers, Merseyside Branch (joint meeting with the Institute of Cost and Works Accountants and the Institution of Production Engineers, at Radiant House, Liverpool), at 6 30 p m —Mr W C Puckey "The Measurement of Productive Efficiency"

Manchester Metallurgical Society (joint meeting with the Iron and Steel Institute, at the Engineers' Club, Albert Square, Manchester), at 6 30 p m —Mr R Toye "Instrumentation of Steel-making Furnaces—some of the Problems"

Society of Chemical Industry, Food Group (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S W 1), at 6 30 p m —Discussion on The Training of Food Technologists" (to be opened by Dr J B M Coppock)

Society of Glass Technology (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 6 30 p m —Dr R R Pearce "The Use of Glass in Television"

Society of Instrument Technology, Control Section (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 30 p m —Mr G G Sutton "The Design of an Automatic Spectrometer"

Institute of Fuel, North-Western Section (joint meeting with the Stanlow Branch of the Institute of Petroleum, at the Grosvenor Hotel, Chester), at 7 p m —Mr C D Brewer and Mr B H Thorp "The Influence of Fuel Characteristics on the Behaviour of Compression Ignition Engines"

Textile Institute, Midlands Section (joint meeting with the Midland Section of the Society of Dyers and Colourists, in Room 104, College of Technology, Leicester), at 7 p m —Mr E J Davies "The Reactions of Fabrics and Finishes to Dry Cleaning"

British Institution of Radio Engineers, South Midlands Section (at the East Midlands Electricity Board, Coventry), at 7 15 p m —Mr H J Barton-Chapple "A Survey of Television Development and its Problems"

Thursday, February 15

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Mr W J Corlett "Population Trends" *

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 40 p m —Scientific Papers

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Mr H E Jeffrey "Notes on Fire Prevention and Fire-Fighting, with particular reference to the Kolar Gold Field" , Mr Victor Hodgson 'Filling Stopes with Glacial Drift at Buchans, Newfoundland"

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Mr D V Lindley "Mathematical Foundations of Statistics"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Prof F S Dainton "Atoms and Radicals in Aqueous Solutions" (Tilden Lecture)

Royal Aeronautical Society (at the Sibree Hall, Coventry), at 7 30 p m —Mr Handel Davies "Some Aspects of Flight Research"

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W 1), at 7 30 p m —Dr J Newsome "Recent Investigation into the Treatment of Schistosomiasis by Miricil D in Egypt'

University of London (in the Swanley Hall, Wye College, Wye, Kent), at 8 15 p m —Prof C H Waddington, F R S "Science and Ethics" *

Friday, February 16

Society for Endocrinology (at the Zoological Society, Regent's Park, London, N W 8), at 11 a m —Symposium on 'Endocrinological Aspects of Fertility"

Eugenics Society (at Manson House, 26 Portland Place, London, W 1), at 5 p m —Dr G C L Bertram "Eugenics and Human Ecology" (Galton Lecture) *

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p m —Air-Commodore F R Banks "The Aviation Engine" (James Clayton Lecture)

Society of Dyers and Colourists, Manchester Section (at the Gas Showrooms, Town Hall Extension, Manchester) at 6 30 p m —Dr H W Ellis "The Physical Measurement of Dyeing, with special reference to the Ellis Photometer" Discussion on the Physical Society (Colour Group) Colour Terminology Report (introduced by Mr G S J White)

Royal Institute of Chemistry (at the Technical College, Brighton), at 7 p m —Dr W H J Vernon "Corrosion Processes and their, Prevention"

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 7 p m —Scientific Papers

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof C F Powell, F R S "The Cosmic Radiation"

Saturday, February 17

British Interplanetary Society, North-Western District Centre (at the Adult Education Institute, 49 Lower Mosley Street, Manchester), at 7 p m —Mr J Humphries "The Design of Rocket Motors"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Scientific Technologist (with a good general training in chemistry, preferably up to degree standard) in the Coal Survey Laboratory in Glasgow—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, endorsed TT/291 (February 17)

Senior Hospital Physicist (with honours degree in physics and experience in hospital physics) at the Radiotherapy Centre—The Secretary, United Birmingham Hospitals, Queen Elizabeth Hospital, Birmingham 15 (February 17)

Fuel Technologist (with first- or second-class degree in applied chemistry, or equivalent), and a Fuel Analyst (pass degree in chemistry or equivalent desirable)—The Personnel Manager, Colonial Development Corporation, 19 Curzon Street, London, W 1, quoting Serial No 54 (February 19)

Principal of the Wolverhampton and Staffordshire Technical College—The Director of Education, Education Office, Wolverhampton, endorsed 'Principal of Technical College' (February 22)

Assistant Lecturer in the Department of Electrical Engineering (electrotechnics)—The Registrar, The University, Liverpool (February 24)

Scientific Officer (with an honours degree in chemistry with postgraduate experience in agricultural chemistry, or an honours degree in agricultural chemistry) in the Chemical Research Division of the Ministry of Agriculture—The Director of Establishments, Ministry of Finance, Stormont, Belfast (February 27)

Chief Lecturer in Physiology at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (March 10)

Lecturer or Assistant Lecturer in Chemistry, an Assistant Lecturer in Botany, an Assistant Lecturer in Mathematics, and an Assistant Lecturer in Zoology, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (March 31)

Professorship in the Department of Physics—The Registrar, University of Manitoba, Winnipeg, Canada (March 31)

Perrott Studentship in Psychical Research—The Secretary, Perrott Studentship Electors, Trinity College, Cambridge (April 30)

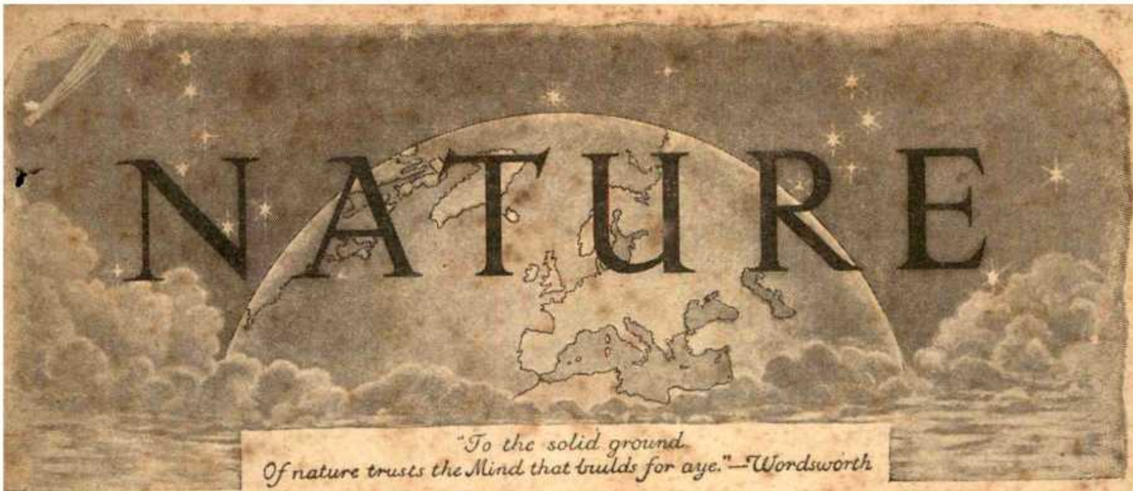
Analyst to take charge of the chemical laboratory connected with crop testing—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Lecturer in Biology, to take classes up to final degree standard in zoology and/or botany—The Director of Education, The Polytechnic, 309 Regent Street, London, W 1

Research Assistant, with degree in chemistry, physics or engineering—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey

Scholarships in Textile Technology, Textile Engineering, Textile Chemistry or Dyeing—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester

Senior Assistant in the Department of Physics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S W 11



NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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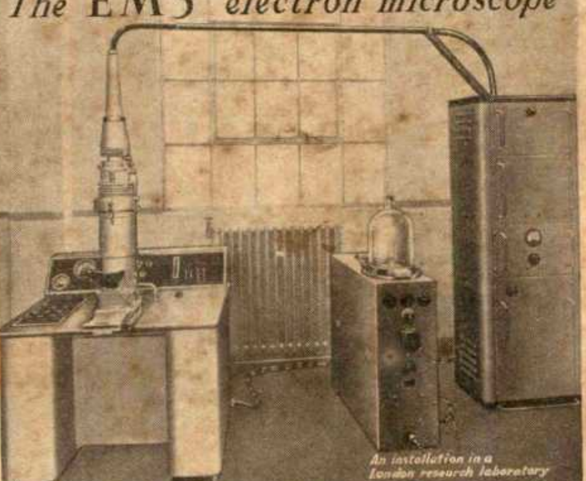

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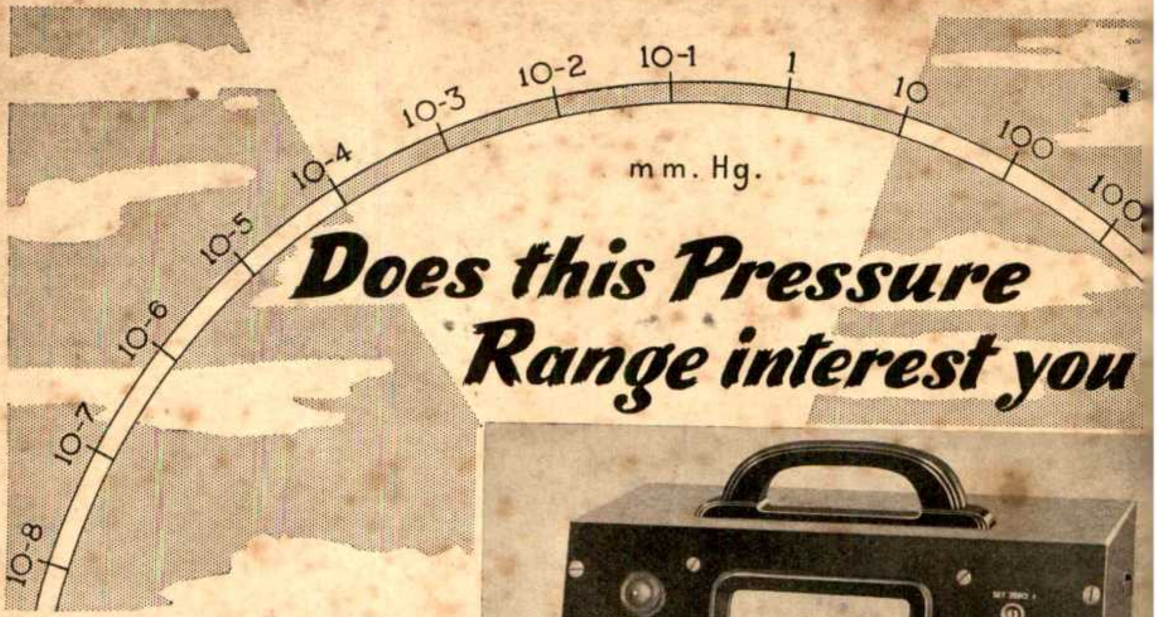

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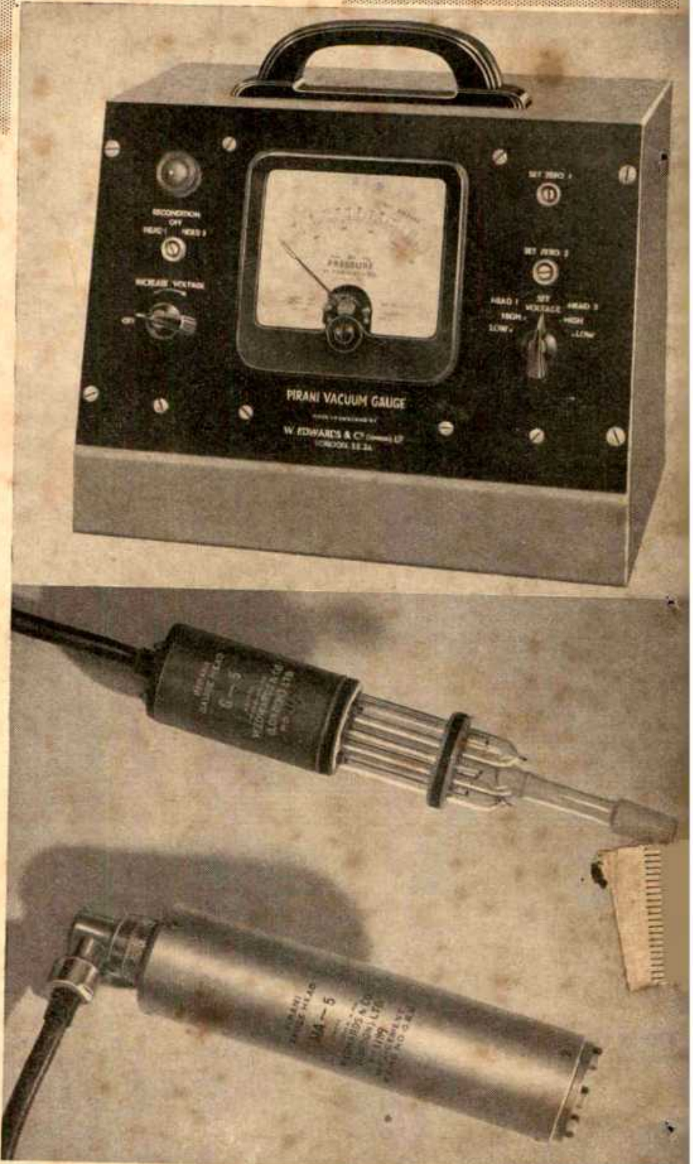

NATURE

No 4247 SATURDAY, MARCH 24, 1951 Vol 167

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Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C.2.
Telephone Number: Whitehall 8831
Telegrams Phusis Lesquare London
Advertisements only should be addressed to
G Scott & Son, Ltd , Talbot House, 9 Arundel Street, London, W C 2
Telephone Number Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad
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BROADCASTING IN GREAT BRITAIN

FROM several points of view, the report* of the committee under the chairmanship of Lord Beveridge which has been considering the future of broadcasting in Great Britain is of great interest to scientific workers It deals, especially in the chapters on higher-frequency broadcasting and on television, with technical matters with which some are specially and directly concerned , indeed, the policy to be followed by the Corporation in some respects must depend very closely upon the rate of scientific and technical advance in those fields The educational aspects of broadcasting are likewise of direct interest, for scientific men need no reminder that broadcasting as an influence on men's minds has great possibilities, either for good or for evil It is indeed a power as great in its way as atomic energy, and on its wise use the peace and sanity of the world largely depend

Broadcasting in Great Britain, however, has hitherto been a monopoly, though a monopoly independent of the State, and there are issues arising out of that aspect of broadcasting which are of very wide importance Regarded as a public corporation—and Lord Beveridge and his colleagues, with one dissentient, recommend the continuance of broadcasting as a monopoly—the British Broadcasting Corporation is of more than passing interest as a study of the relations between government and the public corporation, of the way in which power and responsibility are linked and some degree of ultimate public control exercised There are problems of keeping such an independent body in touch with the public it serves, problems of the maintenance of standards and problems of professional and of staff relations

On all these matters the report has much to say that is sound and wise Overshadowing all in importance, however, is the issue of monopoly, and the question whether or not that should be continued Only if an affirmative answer is given is it profitable to examine in detail the measures which can be adopted as safeguards against the dangers of monopoly, though admittedly an affirmative answer could scarcely be given without some assurance that effective safeguards exist

"Broadcasting," says the majority report in a passage quoted again by Mr Selwyn Lloyd in his minority report, "is the most persuasive, and therefore one of the most powerful of agents for influencing men's thoughts and actions, for giving them a picture, true or false, of their fellows and of the world in which they live, for appealing to their intellect, their emotions and their appetites, for filling their minds with beauty or ugliness, ideas or idleness, laughter or terror, love or hate " Elsewhere the report observes "if broadcasting can find a serious audience it is an unrivalled means of bringing vital issues to wider understanding The evil is that broadcasting is capable of increasing perhaps the most serious of all dangers which threaten democracy and free institutions to day—the danger of passivity—of acceptance by masses of orders given to them and of things said to them Broadcasting has in itself a tendency to encourage passivity, for listening as such, if one does no more, is a passive occupation Television may be found to have this danger of passivity in even stronger form "

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* Report of the Broadcasting Committee, 1949 (Cmd 8116) Pp vii+327 (London H M Stationery Office, 1951) 6*s* 6*d* net

This appears to be the main reason for Mr Selwyn Lloyd's disagreement with the majority report he holds that it is not in the public interest that all this actual and potential influence should be vested in a public or private monopoly The four principal evils of monopoly are size and unwieldiness, complacency and rigidity, leading to hindrance of development, the existence of only one employer, and excessive power, and the last is regarded by him as most serious A memorandum submitted in evidence by Mr Geoffrey Crowther and Sir Robert Watson-Watt, which included a scientific argument to prove the possibility, through the use of very-high-frequency broadcasting, of establishing at least three competitive corporations, also referred to the danger that excessive power over men's thoughts concentrated in a single organization would lead to complacency, lack of imagination, and deadly uniformity of public opinion This memorandum concluded with a strong appeal for freedom and competition, urging that the only ultimate safeguard of liberty lies in diversity, and that the Committee's report would be a critical factor in the resuscitation or the destruction of the free society

The other members of the Committee were fully alive to these dangers and arguments, but they firmly reject, as a guiding principle in broadcasting, competition for numbers of listeners Such competition, they hold, is fatal to any social purpose, though they do not accept the assumption that in broadcasting a monopoly alone can have high standards and social purpose Nor, in spite of their generous tribute to the past achievements of the B B C, do they accept the argument that the B.B C should therefore be continued on exactly the same lines as in the past The Committee differs from the critics of monopoly in means rather than in ends, and believes that the ends which all desire can be better served by a single chartered corporation for the United Kingdom, including the overseas services and television, as well as sound broadcasting, subject to appropriate internal and external safeguards against abuse of power

Nevertheless, the Committee in this report appears to dismiss the argument against monopoly a little too summarily The evidence collected by Mr R H Coase, for example, in his recent study of this aspect of British broadcasting, suggests that public discussion of this issue is only just beginning The new charter should not prejudice such discussion, especially since the Beveridge Committee itself recognizes that developments in very-high-frequency broadcasting may not only assist in achieving a prime purpose of the B B C by enabling it adequately to cover the United Kingdom by sound broadcasting, but may also make possible more diversity and independence of programmes The Committee rightly maintains that the placing of sound broadcasting throughout Great Britain on a more satisfactory basis in respect of reception than it is to-day should be regarded as an aim of very high priority Furthermore, it realizes that, if certain difficult technical and practical problems are solved, exploitation of higher frequencies in sound broadcasting opens the possibility of transforming the wave length situation and of adding local to centralized broadcasting It has not, however, recognized that such developments may also profoundly affect the monopoly position and the possibility of competitive broadcasting, as well as its own proposals for devolution The balance of informed opinion may be against terminating the monopoly at the present time, and while the Committee may well be right in recommending that the whole question should not be re-opened in five years time, with all the difficulties that such an impending investigation would hold for the planning of broadcasting, it is not quite clear that there should be no fixed time limit for the new charter That might well have been set at fifteen years, unless in the meantime the committee charged with the responsibility for a quinquennial review of the finance, work and policy of the Corporation advised the Government that technical developments made it advisable to reconsider this issue of monopoly

There should not, even then be the need to make so exhaustive a review as the Beveridge Committee has done It is clear from the report that the Committee has recommended that the duration of the new charter should be indefinite, essentially because it cannot be foreseen when technical developments or social changes will make a new fundamental inquiry appropriate Provided it is realized widely that this recommendation is not intended to prejudge the issue of monopoly, no great exception need perhaps be taken to it The more immediate practical issue is the scrutiny by public opinion of the safeguards against abuse of monopoly which are recommended in this report, and particularly from the point of view of ensuring not only enterprise but also efficiency

The majority recommendations of the Committee will probably obtain ready assent in Parliament, but some of the other proposals, particularly those relating to the safeguards against abuse of monopoly, may well be the subject of considerable further debate First, there is the problem, given the continued independence of the broadcasting authority, in programme policy and in general administration, which is a corner-stone of the Committee's proposals, of making a public-service monopoly subservient to the public without recourse to direct parliamentary control The Committee's rejection of the latter will be endorsed by some who do not follow it in its exposition of the way the governors must assume the function of a Minister in keeping his department in touch with public opinion and subject to external criticism

Apart from these details, however, there is still the issue of parliamentary responsibility As regards Ministerial responsibility, the Committee makes no recommendation beyond indicating the need for clear decision, and that responsibility for allocation of wave-lengths or collection of revenue should rest with the Postmaster-General Nevertheless, on the evidence in this report, it seems clear that the responsibility of the Government in such matters as the appointment of governors, the exercise of the powers of veto and instruction, the prescription of information to be furnished by the Corporation to Parliament, the appointments of the quinquennial committee of review and of the Television and Higher Frequency Advisory Committee, and the like, would be more appropriately discharged by the Lord President of the Council than by the Postmaster-General

For the rest, the Committee proposes that the Corporation should be required to include specified information in its published reports and accounts On the conduct of its finance, the report, indeed, pays a very high tribute to the B B C , but it is also pointed out that, although the Corporation knows practically everything that needs to be known about its own financial operations, it has told Parliament and the public very little about them Both Parliament and the public are, in the opinion of the Beveridge Committee, entitled to much more than the minimum of information required by statute of private companies, and the decision as to what information is desirable should be taken by the Government and not by the B B C, though the latter should be consulted The decision should be the Minister's, and it must be defended by him if challenged in Parliament This annual report would also be supported by the 'independent' quinquennial review already indicated, which would cover the action taken by the governors on the recommendations of the Beveridge Committee The charter, it is proposed, should also name certain purposes which the governors would be required to pursue, though leaving them free as to method Two of them—the development of very-high-frequency broadcasting and television—have already been mentioned the remaining three relate to bringing the work of the Corporation under constant and effective review from outside, provision for effective staff representation and discussion, and regional delegation to broadcasting commissions for Scotland, Wales and Northern Ireland

The new conception of the functions of the governors of the B B C which are implicit in this report should be noted They are visualized as agents for informed democratic control, collectively the equivalent of a Minister, and their continued appointment for part-time rather than full-time is intended to keep them responsive to public opinion They are also to be provided with a channel for both popular and expert criticism from outside, and for this purpose a public representation service is proposed which, besides taking over audience research, would also be responsible for such functions as receiving and reporting on external criticism and suggestions, the critical review of home programmes, and the systematic review of overseas programmes, suggestions for the establishment of advisory committees and the study of broadcasting methods and programmes in other countries It is emphasized that a principal purpose of the suggested public-representation service would lie in making it possible for the governors to get carefully considered reports of criticism upon programmes Some weight is also attached to the suggestions for increasing the organization for specialist advice which already exists, and for further experiment with advisory bodies by the regional commissions already mentioned

The governors are also regarded as responsible to some extent for the interpretation or explanation of the Corporation to the public, from this point of view the report raises the question of the civil rights of governors, and urges the need for further clarification of their position, for example, as members of the House of Lords when broadcasting questions are debated there At such times intricate constitutional questions may be raised, as well as that of the independence of individual governors and their rights

This view of the functions of the governing body leads to some important problems in relation to the general administration of the Corporation The Committee clearly recognizes that some delicate questions are raised by its observations on relations with the board of management, and on those between the director-general and the chairman of the board of governors How critical such relations can be no reader of Lord Reith's "Into the Wind" will need reminding It does not appear, however, that the Beveridge Committee appreciates the extent to which its proposals may blur the distinction between broad oversight of policy and day-to-day management, and make efficient administration just as difficult as under direct parliamentary control The whole of the complicated advisory apparatus which is proposed appears to be directed to the board of governors, and not to those carrying the immediate administrative responsibility

The main criticism to be made of the proposals is, in fact, that they tend to weaken the authority of the director-general and of the central organization of the Corporation By weakening the power of responsible decision, insisting on too many checks and balances, and making it necessary for executives to force every decision through a network of committees, the proposals may well make the B B C even more bureaucratic than at present More important still, they may make it much more difficult to secure and keep executives with the vision, enterprise and decision that are imperative if monopoly broadcasting is to avoid the dangers of timidity, complacency and unadventurousness

The proposals for three regional broadcasting commissions, though not without difficulties, seem much more promising Indeed, Mr John Coatman has pointed out that the Committee might well have gone further and with advantage have included regional commissions for England as well, thus minimizing the dangers of exaggerated nationalist sentiment inherent in the present proposals The Committee was impressed by the comparatively small contribution to regional programmes which was of local origin, by the limited scope of the existing regional advisory councils and by the advantage, from the point of view of staff, of the relatively small organization of a region over that of London It was less impressed by demand for autonomy voiced both in Scotland and in Wales, though it recognized the dangers which could attend excessive centralization But in its concern not to break British broadcasting into fragments, it does not appear to have pursued the idea of federation sufficiently, or to have provided for the regional devolution in England which is equally, if not more, important than in the three regions suggested, if the full regional contribution is to be secured

The regional development of broadcasting is attended with certain technical difficulties on the financial side, which may make it of less general interest from the administrative point of view than most aspects of the Corporation's organization The extent to which the Corporation has so far been independent of the political field also makes its experience rather less relevant to that of other experiments in public ownership and control, though exploration of the issue of Ministerial responsibility as recommended might be illuminating Nevertheless, there is much in this report that bears closely on the problems which the nationalized industries are now facing, and some of these are to be found in the minority report and in the notes and reservations of individual members of the Committee which are appended

Few big public or private corporations could have emerged, as the British Broadcasting Corporation has done, from so searching an inquiry with such credit, but if the future is to show as distinguished a record, there must be no lack of the stimulus of informed and constructive criticism No matter how excellent the internal organization of such a body, such criticism is the ultimate safeguard against abuse of power, and above all is the final means by which we can ensure that broadcasting is fully developed and utilized to assist a democracy to understand the issues upon which it may be required to vote or act

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REFERENCE-BOOK OF DAIRYING

A Dictionary of Dairying
By Dr J G Davis Pp xx+856+76 plates (London Leonard Hill, Ltd, 1950) 37*s* 6*d*

THERE has always been a dearth of British text-books on dairying, apart from works dealing with particular branches such as dairy husbandry, dairy chemistry and dairy bacteriology In view of the extensive literature now devoted to publication of original work in the fields of dairy science and technology, the lack of complementary standard text-books is felt acutely by investigators, teachers and practical dairy workers Certainly there is a wide choice of American text-books, but unfortunately many of these are inadequate, and all refer to conditions which frequently differ from those met with in Great Britain In a single volume, Dr J G Davis and his twenty-eight collaborators have now amassed the broad fundamentals of modern dairying, covering the scientific, technological and economic aspects True, this is not a text-book, but rather, as the title indicates, a work of reference arranged alphabetically, nevertheless, it will be very widely used

In an omnibus work of this character considerable variation in treatment is almost inevitable, and consequently there are differences in quality between the various sections Some subjects are accorded the briefest—occasionally superficial—reference, while others (particularly contributed sections) receive an approach to detailed text-book treatment Purely scientific matters are, perhaps, accorded the major emphasis In order to confine the whole field of dairying within restricted bounds, most subjects have, very wisely, been limited to the bare minimum Nevertheless, the information given is basically sound and readily intelligible, in addition, numerous cross-references are employed and further sources of detailed information are indicated

Certain fields wherein the existing literature is deficient or confusing have been selected for more detailed treatment In his choice of such material the author has on the whole been very happy Thus, it is particularly pleasing to find useful sections dealing with milk-bottle fillers, bottle washing, and the problems of detergency in dairy practice Some of the material presented in the sections on dairy management and the costing of milk distributive operations is also original and will no doubt provoke discussion Other relatively long sections deal with the isolation and identification of lactic acid bacteria, coliform bacteria, thermophilic and thermoduric bacteria, bacteriological grading of milk, cleansing and sterilization of dairy plant, water supplies for dairy premises, dairy effluent disposal, cooling of milk at the farm, the pasteurization of milk, and the manufacture of ice cream, cheese, condensed milk and dried milk The summaries of recent research findings in these fields will be valuable to many Dairy bacteriology tends to receive more emphasis than does dairy chemistry, but this is the present fashion

Notwithstanding the immense labour involved in the production of this volume, a few further additions may perhaps be suggested The essential dairy services might receive more generous treatment, thus steam raising, a basic requirement of all dairy operations, is scarcely mentioned and the references given are inadequate, while the use of electric power for dairy purposes is accorded similar treatment A special section on the design of dairy buildings and the lay-out of plant would be valuable It is surprising to find little information on the genera properties, processing and marketing of liquid cream in spite of present restrictions in Britain, cream production is an important dairying activity which merits more extended treatment The production of infant foods, which absorbs large quantities o milk, might also find a place The problems of milk transport other than retail delivery, and the design and standardization of milk containers are othe important matters which deserve fuller discussion Throughout the book a more generous use of explanatory diagrams, as opposed to illustrations would assist non-expert readers These omissions ar relatively small matters which can be put right in future editions

The "Dictionary" will undoubtedly become standard work of reference Indeed, the appearanc of this encyclopædic volume (at an unusually modes price) is quite an event in the dairying world

E L Crossley

STATISTICS FOR EXPERIMENTAL DESIGN

Experimental Designs

By Prof William G Cochran and Gertrude M Cox Pp ix+454 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1950) 46*s* net

THIS book is essential to every statistician concerned with experimentation When the discipline of experimental design was first introduced into quantitative biological research, materials and treatments were made to conform to one or two simple patterns, notably the randomized block, Latin square, and simpler factorial types, more recently, the trend has been reversed, with the better purpose of constructing designs that will compare the treatments most precisely within the limitations imposed by the materials The consequent proliferation of designs has made difficult even the remembering of where papers describing their construction and analysis may be found Here, for the first time, is a codification of most of the simpler and more useful types

After an introductory chapter describing the role of statistical science in the planning of experiments, Chapter 2 explains how precision can be modified by replication and by grouping experimental units into blocks The general principles of the analysis of variance and covariance are expounded in a long third chapter, the basic linear model, and the meaning and advantages of orthogonality, are particularly well illustrated These three chapters deserve study by all who use statistical science, for they form an excellent account of the relationship between the arrangement of an experiment and its statistical analysis

Apart from a short chapter on randomization, the remainder of the book consists of systematic discussion of different designs Randomized blocks, Latin squares, factorial designs (unconfounded and confounded), quasi-Latin squares and the various types of incomplete block designs—balanced and partially balanced, rectangular and cubic lattices, lattice squares, and Youden squares—are all described, with many numerical examples drawn from agricultural, biological, and industrial research Unless the method of construction is obvious, plans are shown for each type of design, with various numbers of treatments, these plans are indexed according to number of treatments and degree of replication, so that the user may easily find one suited to his needs and has then only to randomize the arrangement This section of the book will be used for reference rather than for consecutive reading, though it could be the basis of an excellent course of instruction

Had the authors done no more than list designs and methods of analysis they would have performed a valuable service In addition, their extensive experience of statistical science has enriched their catalogue with an immense amount of information and advice about the interpretation of experiments The importance of assumptions used in the analysis of variance, the analysis of experiments when some observations are missing, and the interpretation of series of experiments are among the topics so considered

When the feast is so bountiful, to ask for more dishes may seem unkind nevertheless, we must hope that the authors will give us either a second volume or an expanded second edition Further consideration of 'mixed' confounding schemes, especially of the incompletely balanced types that are sometimes inescapable, would be helpful Fractional replication of factorial designs introduces special problems of interpretation, and the absence of numerical examples might be remedied More might be said about long-term agricultural experiments Finally, Rao's suggestions for a standardized method of analysis for incomplete block designs might provide an escape from the difficulty of learning a different computational scheme for each type These remarks relate not to blemishes but to points of departure for future work "Cochran and Cox" is already, and will long remain, the standard guide to experimental design

D J FINNEY

HUMAN BLOOD GROUPS

Blood Groups in Man

By Dr R R Race and Dr Ruth Sanger Pp xv+290 (Oxford Blackwell Scientific Publications, Ltd , 1950) 30*s* net

AT the beginning of the century, Landsteiner described the discovery of the *A*, *B* and *O* blood groups in man Since that time many efforts have been made to discover other human blood groups Such methods were by using as test sera suitably absorbed animal sera, and later by the injection of human red cells into animals This latter method led to the discovery of the *M*, *N* and *P* groups Subsequent experiments involving the injection of monkey blood into rabbits and guinea pigs and the testing of such antisera against human cells led Landsteiner and Wiener in 1940 to the discovery of the *Rh* blood group

From this point onwards the discovery of new human blood groups advanced rapidly This was due not only to the discovery of the *Rh* group, but also to the fact that this group was found to be the main agent in iso-immunization during pregnancy and the cause, in many cases, of hæmolytic disease of the newly born In certain cases the antibodies formed were due to other blood groups A further factor has been the increasing use of blood transfusions and the study of the occasional reactions resulting from these, this was the way in which the recent 'Duffy' blood group was discovered New techniques have also been devised for the detection of iso-antibodies, and notable among these have been the use of an anti-human globulin serum for detecting incomplete iso-agglutinins

This book, by Drs R R Race and Ruth Sanger, describes all the new ideas and the techniques which have been developed within the past ten years and also gives a complete and comprehensive description of the inheritance, characters and method of detection of the human blood groups The study and understanding of blood-group inheritance is indeed important for, as Prof R A Fisher states in a foreword, there is now a good marker on nine out of twenty-three autosomes, eight of them are blood-group markers

The book is very readable and inspiring for one who works in this particular field of blood-group serology One of the most valuable sections is that on the identification of antibodies and the determination of the nature of unknown antibodies occurring in human sera For the general scientific worker, geneticist and perhaps clinician, the work is difficult to understand and really would be better described as recent advances in the study of blood groups It would be advisable, therefore, for anyone unacquainted with this particular field, or wishing to gain further knowledge of it, to read some preliminary work in the first instance The descriptions of techniques in this book are somewhat less complete than one would have liked, but it is probable that the authors feel that practical experience is the only way to learn these techniques properly, since they say, in referring to the testing of *Rh*-antigens, 'to achieve accuracy a long apprenticeship in error seems necessary"

Drs Race and Sanger are to be congratulated on the production of this book, which is packed with knowledge, free from mistakes, and will form an invaluable reference book for all biologists and geneticists, but its proper place for those actually working in this field will be beside them on the laboratory bench F STRATTON

SPECTROSCOPY—EXPERIMENTAL, THEORETICAL AND IMAGINARY

Practical Spectroscopy

By C Candler Pp viii+190+4 plates (London Hilger and Watts, Ltd, 1949) 21*s* net

Absorption Spectrophotometry

By G F Lothian Pp 196 (London Hilger and Watts, Ltd, 1949) 26*s* net

An Introduction to Molecular Spectra

By Dr Raynor C Johnson Pp xiii+296+8 plates (London Methuen and Co, Ltd, 1949) 40*s* net

The Interpretation of Spectra

By William Mayo Venable Pp v+200 (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd, 1948) 48*s* net

THE first two of these books deal with the experimental side of spectroscopy, mainly with Hilger instruments, and indeed are to some extent glorified instrument catalogues C Candler's book is most ably written and gives the benefit of his expert knowledge on the subject, but it is not to be regarded as a comprehensive "Practical Spectroscopy" It is a course for students using a wave-length spectrometer and accessories It covers qualitative and quantitative spectrochemical analysis, absorption spectra, Raman spectra, the infra-red region and some interferometry More than a hundred experiments are suggested, and certainly no one with this book who was planning a course in spectroscopy would be short of ideas for experiments, although many of them seem rather elaborate and require a lot of accessory equipment not normally available in a teaching laboratory The emphasis is rather chemical

The same is also true of G F Lothian's "Absorption Spectrophotometry" This book is, however, a fairly comprehensive treatment of the subject, and, although the use of Hilger instruments is to the fore, others such as the Perkin–Elmer and Grubb–Parsons infra-red spectrometers are briefly described This book covers the experimental technique, for the ultra-violet and visible, by photographic, photo-electric or visual means, and also for the infra-red I would like to have seen an extension to cover the technique of measurements at liquid-air temperatures, and I think that the troublesome Eberhard effect in photographic work is dismissed rather lightly The book is very well illustrated, both with instrumental photographs and absorption curves The principles and terminology are clearly dealt with, and the applications of spectrophotometry to inorganic and organic analysis, to biological problems and to the elucidation of the structure of complex molecules are described

The most important of the four books under review is "An Introduction to Molecular Spectra", by Dr R C Johnson, which covers mainly the spectra of diatomic molecules but includes chapters on the Raman effect, on the electronic and infra-red spectra of polyatomic molecules and on applications of molecular spectroscopy to astrophysics, chemistry and biochemistry The treatment is from the point of view of an experimental spectroscopist endeavouring to systematize a spectrum, and Dr Johnson gives the reader the benefit of his very considerable experience in this field, his treatment of the vibrational and rotational structure of the spectra of diatomic molecules being very clear This section is, however, rather marred by being badly out of date, many examples being, as a result, unsuitable, there are a few errors and omissions—on p 152 the formulæ for rotational intensity factors are likely to lead to trouble because it is not stated that the value of K to be used is whichever is the greater of K' or K'', the rotational quantum numbers in the upper and lower electronic states No knowledge of wave mechanics or group theory is assumed, and the book is clearly written and easy to read It thus forms a valuable introduction to the subject and may be recommended

In "The Interpretation of Spectra", W M Venable gives an original and highly unorthodox interpretation of the cause of spectra It is difficult to know whether to ignore, laugh at or seriously to criticize this work The last approach is probably the best, but is the most difficult in a limited space The whole treatment is rather complex because of the detailed numerical data cited and the use of a lot of algebraic expressions The first part seeks to establish relationships between the primary and secondary spectrum of hydrogen Mr Venable then rejects the Bohr-type model of atomic structure on the grounds that on electromagnetic theory a moving electron will radiate and cannot form a stationary energy state He assumes that in equilibrium the electron is poised at a distance from the nucleus by the usual attractive force varying as $1/r^2$ and a repulsive force as $1/r^3$ Scattering experiments showing that the $1/r^2$ law alone holds down to very small distances adequately disproves this part of his theory The author then assumes that a single atom can give only continuous radiation, and invokes oscillations of electrons in the field of complex atom-groups or "line-molecules ' to account for line spectra Such a theory could not explain the line absorption spectra of cold monatomic gases (for example, the absorption of $\lambda 2537$ of Hg in laboratory air) or the absence of marked pressure dependence Little attempt is made to deal in detail with molecular spectra, the complex structure of which has been explained so well in terms of orthodox theory

The book may be recommended to nuclear physicists, they will find the last chapter very amusing It is a pity, though, that so much obviously painstaking work and original thought has not been put to better use A G GAYDON

A PALYNOLOGICAL TREASURE-HOUSE

By Dr. H. G. BAKER
Department of Botany, University of Leeds

FRANZ ANDREAS (FRANCIS) BAUER was born in Feldsburg, Austria, in 1758. He settled in England some thirty years later as a result of a meeting with Sir Joseph Banks, who gave him employment as an artist at the Royal Gardens in Kew, where his title eventually included that of 'Botanical Painter to His Majesty George III'. During his life at Kew (which ended in 1840) he produced illustrations of complete and dissected plants which are consistently of the very highest quality. Yet much of his work has remained generally unrecognized, a situation which has only recently been improved by the devotion of a chapter to this great artist and his brother by the chroniclers of "Botanical Illustration", Blunt and Stearn[1]. Nevertheless, the drawings made by Francis Bauer of microscopical subjects are scarcely dealt with by these historians, who are, naturally enough, concerned almost entirely with habit studies of flowering plants.

In the historical section of his book on "Pollen Grains", Wodehouse[2] gives a list of species the pollen-grains of which have been drawn by Bauer. These drawings, which were never published, are bound together in a single volume which is in the Botanical Library of the British Museum (Natural History) at South Kensington. It bears the title "Drawings by Francis Bauer, F.R.S., Epidermis, Hairs, Pollen Grains, Monstrosities".

The primary object of my own consultation of this volume was to see whether or not Bauer had observed the pollen-dimorphism which is to be found in the tribe Staticeæ of the Plumbaginaceæ. The discovery of this dimorphism is usually attributed to MacCleod[3], who described it (without appreciating its significance) in *Limonium vulgare* Mill. in 1887. However, Bauer, who studied the pollen of *Armeria maritima* Willd. (as '*Statice Armeria*'), appears to have used only one, or at the most two plants, yielding only the type of pollen we now call Type *B*[4] but which he has depicted with considerable accuracy. Three tricolpate grains are shown in Plate 64, apparently bursting because, like so many of the grains illustrated, they had been mounted in water. Others are shown in Plate 70 (see Fig. 7).

Type of illustration	Identity of material	Plate	Date
Upper epidermis of leaf	Various genera	4–15	1800
Hairs	*Alyssum creticum*	26	1798
,,	*Lycopsis arvensis*	32	1798
Pollen grains	"*Grevillia sulphoria*" (*sic*)	55	June 15, 1833
Sporangia and style	Ferns and unnamed Angiosperm	58	Feb. 1, 1804
Pollen grains	"New *Oncydium* K.G." (presumably Kew Gardens)	61	Mar. 14, 1834
,, ,,	"*Plargonium* (sic) *inquinans*"	63	June 1833
Bladder	*Utricularia*	69	July 27, 1831 (also Aug. 18)
Pollen grains	"*Epidendrum Barringtonia*" (sic)	73	May 22, 1802
Pollinia and stamens	Orchid	74	Nov. 16, 1804
Pollen grains	*Strelitzia Augusta*	77	Feb. 1821
,, ,,	"*Caladium ?*"	77	May 7, 1821
,, ,,	*Rhexia Cotyledon*	77	May 25, 1821
,, ,,	*Isopogon* sp.	80	Mar. 19, 1836
,, ,,	"New Yellow, H.S. Garden"	80	1833
Floral parts	*Centaurea* sp.	99	July 1819
Shoot bearing berries	*Viscum album*	100	Jan. 1, 1833

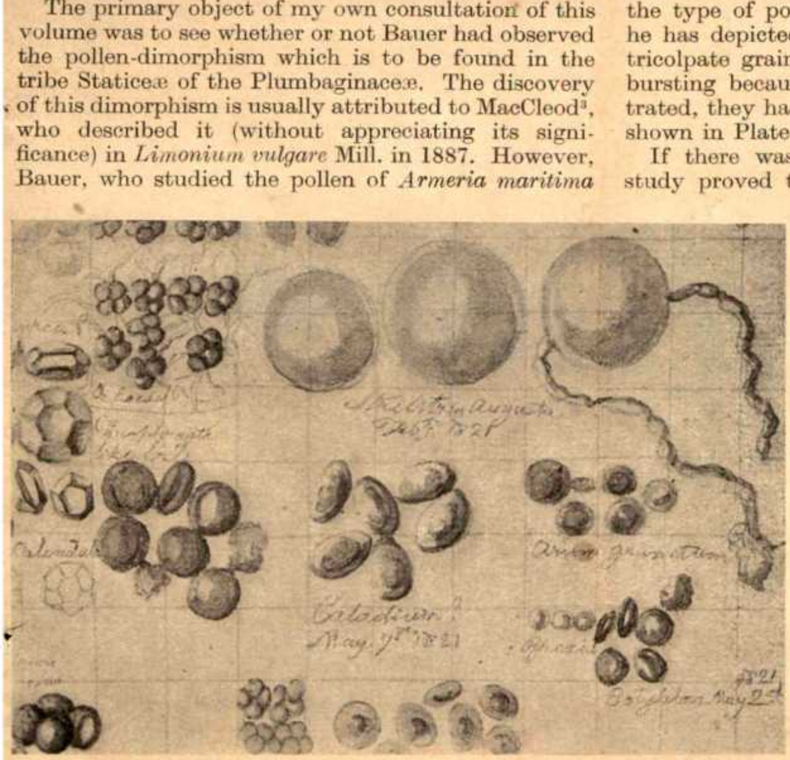

Fig. 1. Pollen-grains of several species from Plate 77, some dated

If there was disappointment in this quest, the study proved to be amply worth while. To begin with, it was possible to bring nearer settlement the uncertain matter of the dates when these drawings were made. We are indebted to Wodehouse[2] not only for a list of species drawn by Bauer, but also for an expert appraisal of the quality of these relatively inaccessible illustrations. The list is, unfortunately, not complete, but it includes more than 175 species drawn from some fifty-seven families. Wodehouse suggests that the work may have extended over a considerable period, possibly from 1790 until Bauer's death in 1840. However, circumstances concerned with the illustrations elsewhere of the pollen of a certain orchid (to be referred to later) led him to postulate (with an admission of improbability) that the collected drawings might all have been prepared between 1832 and 1840.

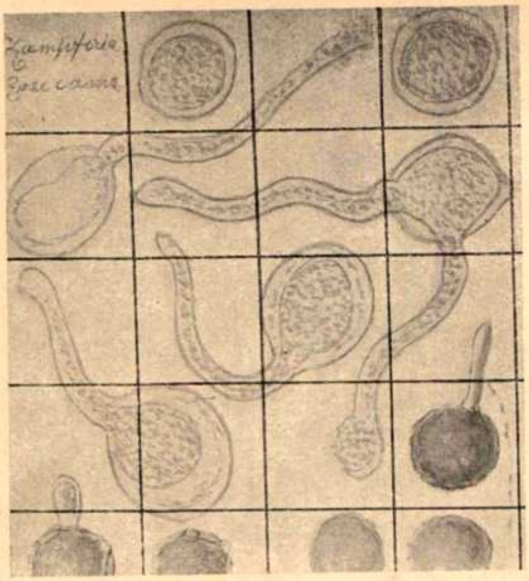

Fig. 2. Germinating pollen of *Kæmpferia Roscœana*, from Plate 80

The first new evidence to emerge was the discovery that, contrary to the statement by Wodehouse, several of the illustrations are accompanied by dates (see the table and Fig. 1). Several tentative conclusions may be drawn from the evidence of these dates. In the first place, it seems that Bauer was concerned with drawing the epidermes and hairs of various genera before concerning himself with pollen-grains. This seems a natural progression from the more obvious to the more intricate, and there is little reason for doubting that all the drawings of pollen-grains were made in the nineteenth century. The earliest dated example is that of the orchid *Epidendrum Barringtoniæ* (= *Lycaste Barringtoniæ*) (Plate 73, May 22, 1802) and the latest the *Isopogon* of Plate 80 (March 19, 1836). From the table it will be seen that even among those concerned with pollen-grains, the plates are not arranged chronologically. Nevertheless, it is reasonable to assume that drawings on the same plate as a dated example are more or less contemporaneous (even though the dates 1833 and 1836 do appear on the same Plate 80). It is likely that all the drawings of pollen-grains were made during a period of roughly thirty years, with the majority after 1820.

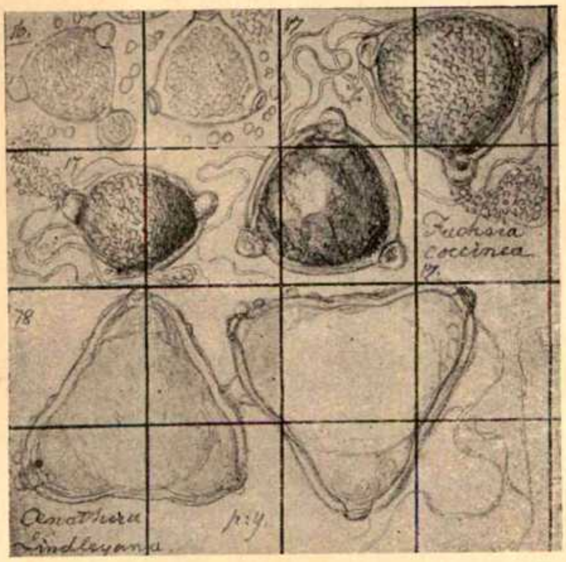

Fig. 3. Pollen-grains of *Fuchsia coccinea* and *Oenothera Lindleyana* showing viscin threads, from Plate 65

The circumstances surrounding the illustrations of the orchid *Pterostylis Banksii* which Wodehouse has thought might bear upon the dating of all the drawings therefore need re-examination. To explain the situation it is necessary to quote the words of Wodehouse[2].

"Besides these unpublished pollen figures some of Bauer's published drawings of plants are accompanied by figures of their pollen grains. For example, the *Curtis Botanical Magazine* for 1832 carries, as No. 3172, an illustration by Bauer of an orchid, the large-leaved pterostylis (*Pterostylis Banksii*). It consists of a beautiful coloured picture of the whole plant, an enlarged flower, enlarged dissections, and a group of seven pollen grains, six in water and expanded and the seventh apparently dry and in air, consequently not expanded. These grains he found quite different from those of other orchidaceous plants. Of them he says:

" 'I have now, on the second of May, examined the pollen grains with Ploessel's grand microscope, and to my great surprise, have found a total deviation from those of all the hundreds of specimens of orchidaceous plants I have yet investigated. These grains in their ordinary form consist of three- or four-celled corpuscles. . . . This I consider an important circumstance, and could not be detected by botanists possessed only of a glass of moderate power.'

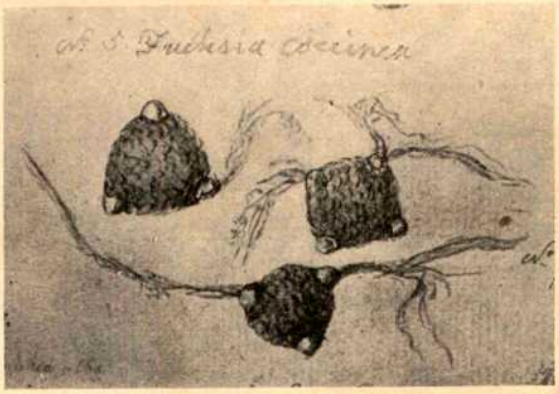

Fig. 4. Pollen-grains of *Fuchsia coccinea* showing viscin threads, from Plate 75

"In this connection it is interesting to note that in Bauer's British Museum collection are illustrated grains of 15 species of Orchidaceæ and that, of these, all except one (*Epipactis pallens**) are represented as four- or occasionally three-celled. So one is at a loss to explain his surprise at finding the grains of pterostylis to be three- or four-celled, unless the figures in the British Museum collection were all drawn subsequently to that of pterostylis, which would require the entire collection to have been done during the last eight years of Bauer's life, which seems improbable. It is true, however, that his figures of the grains of *Pterostylis* do not resemble those of any

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* Now called *Cephalanthera grandiflora* Bab.

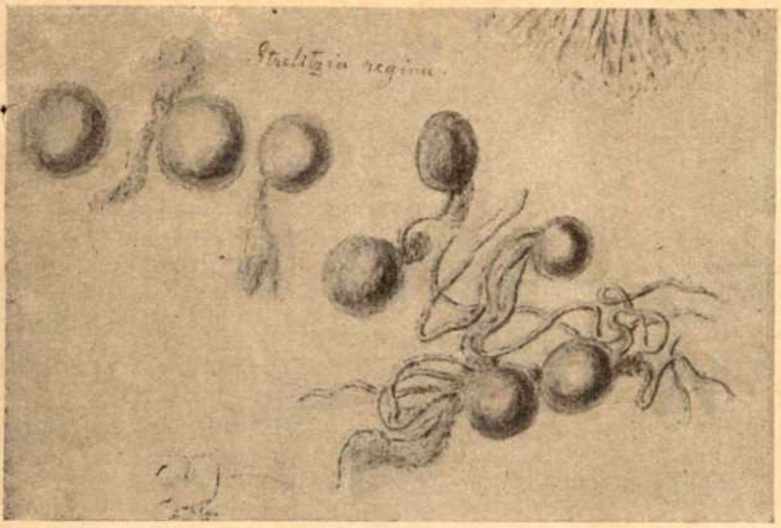

Fig. 5. Pollen-grains of *Strelitzia regina* with interweaving chains of cells, from Plate 72

other orchidaceous plants, nor do they answer his description."

There is a simple explanation for this confusion.

It need not be wondered that Bauer's drawing of the *Pterostylis* pollen does not agree with the description of the grains as consisting of "three- or four-celled corpuscles"—because he never intended to convey that impression. Careful reading of Bauer's quoted words will show that he was referring to the pollen of the "hundreds of specimens" which he had previously investigated as being three- or four-celled and not the *Pterostylis* grains which showed "a total deviation" from this condition.

In a drawing in the British Museum collection (Plate 61), Bauer has shown a ball of grains of *Pterostylis nutans* in addition to the *one-celled* grains of which it is composed. These high-power views of the individual grains show the same pattern of depressed circular areas as on the individual grains in the illustration of the related species in the *Botanical Magazine*. A drawing of *Oncydium* grains on the same plate is dated March 14, 1834.

If the literature of orchidology be consulted it will be seen that Bauer's drawings, which are, as usual, ahead of a general understanding of the significance of what they portray, depict a single-celled condition in *Pterostylis* with complete justification. This genus belongs to Lindley's[5] tribe Arethuseæ, which also includes, among others, the genera *Cephalanthera*, *Pogonia* and *Vanilla*. The pollen of each of these genera is characteristically friable. Darwin[6] emphasizes that the grains of *Vanilla* are single-celled. The pollination-mechanisms described by Cheeseman and Hemsley[7] for *Pterostylis Banksii* and by Godfery[8,9] for species of *Cephalanthera* agree in that smearing of the body of the pollinating insect with the viscid secretion of the stigma is necessary before the pollinia can be picked up. Godfery[8,9] agrees with Darwin[6] that the grains of *Cephalanthera* are tied together by a few weak elastic threads, but are not cemented together to form compound pollen-grains (tetrads) as in most of the Monandræ. Darwin's account of *Cephalanthera* contains a footnote (ref. 6, p. 80) which reads: "The separation of the grains was observed, and is represented, by Bauer in the plate published by Lindley in his magnificent 'Illustrations of Orchidaceous Plants' ". The reference quoted would be more correctly attributed to Bauer himself, for only the notes and prefatory remarks were made by John Lindley. The parts of the book were published between 1830 and 1838. There is not the slightest doubt that Bauer's reputation for accuracy remains inviolate, and that an apparent inconsistency in the dating of his unpublished drawings now disappears.

In view of the fact that the majority of the drawings in the collection at the British Museum were made before 1836, it is most remarkable how many features have been accurately transcribed by Bauer but for which he has not been given credit because his work was not published.

On several occasions, Bauer has drawn perfectly good pollen-tubes emerging from the swollen grains (for example, Plate 80, *Kœmpferia Roscœana*, shown in Fig. 2), and Wodehouse[2] tells us (from other evidence) that Bauer actually discovered and illustrated the germination of the pollinia of *Asclepias* in 1805. Amici is usually credited with being the first to observe the pollen-tube in 1823 (although it was not until 1830 that he followed its path from the stigma to the ovule in a species of *Portulaca*, and it was 1846 when he indicated clearly the part it plays in the stimulation to development of the embryo).

The viscin threads which entangle the pollen-grains of members of the Onagraceæ and Ericaceæ are shown quite accurately and, in some cases (for

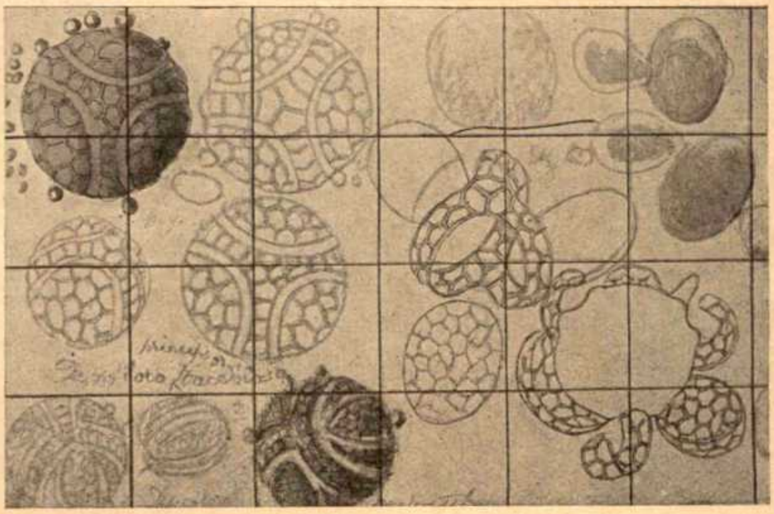

Fig. 6. Pollen-grains of *Passiflora princeps* (or *racemosa*, top left), *P. vespertina* (bottom left) and 'hybrid' (right), from Plate 64. Bauer's labelling is too faint to show clearly in reproduction

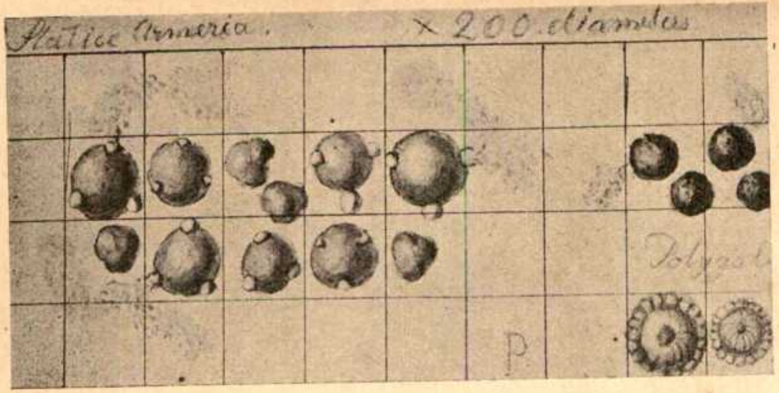

Fig. 7. Pollen-grains of *Armeria maritima* mounted in water; bad pollen unswollen, from Plate 70

example, *Fuchsia*, Figs. 3 and 4), the records are certainly the first for the genus. The discoverer of viscin threads appears to be Rafn[10], who saw them in 1796 linking grains of *Impatiens balsamina*; Link[11] showed in 1807 that they were more distinct in *Oenothera* (see also Bauer's representations in Figs. 1 and 3). More striking than the viscin threads, however, are Bauer's illustrations of the pollen of *Strelitzia* which clearly show the cellular chains weaving among the pollen-grains and derived from the walls of the anthers. They were believed to have been seen first by Palla[12], who published an account of them in 1891 and realized their significance in causing the pollen to cohere and facilitate pollination by birds. Bauer, however, shows them in two separate drawings (Plates 72 and 77, reproduced in Figs. 5 and 1, respectively). It is surprising that Wodehouse[2] does not list the craneflowers among the genera, representatives of which have been drawn by Bauer, for *Strelitzia regina* and *S. Augusta* are both depicted. It was during the period in which the drawings collected here were made that Bauer[13] published his incomparable water-colours of flowering shoots of *Strelitzia*.

For the experimental taxonomist, the most interesting illustration is that on Plate 64 where, between drawings of the very elaborately ornamented grains of *Passiflora princeps* (or *racemosa*) and *P. vespertina*, are shown very disorganized grains labelled "Hybrid" (see Fig. 6). The arrangement is undoubtedly deliberate and must rank as one of the earliest illustrations (if not the very first) of bad pollen in a hybrid between two species themselves with good pollen. Dutrochet[14] is known to have observed aborted pollen-grains in *Prunus* hybrids in 1832.

In the drawing of the pollen of *Statice Armeria* (*Armeria maritima*) contained in Plate 70 (see Fig. 7), the grains were evidently mounted in water. The four large and three medium-sized grains are swollen and bursting through the colpæ, but three small grains are not swollen and not bursting. It is known that bad pollen is produced sometimes in this species, and this accurate representation shows that the small empty grains do not absorb water.

Wodehouse (ref. 2, p. 32) has summed up his notes on Bauer's work with the comment that "He recognised the extent to which family likenesses are borne by pollen-grains and other points which were not cleared up until nearly half a century later. I believe that if Bauer's work could have been published during his lifetime, the science of pollen morphology would now be considerably in advance of what it is to-day." It is not unreasonable to suppose that progress in other fields would also have been accelerated, and it is hoped that this note will stimulate further study of his work.

I am very grateful to the Trustees of the British Museum (Natural History) and, also, particularly to Dr. J. Ramsbottom, then keeper of the Department of Botany, who gave me permission to consult the drawings, made arrangements for their photography and gave permission for their reproduction.

[1] Blunt, W., and Stearn, E. T., "The Art of Botanical Illustration" (London, 1950).

[2] Wodehouse, R. P., "Pollen Grains: Their Structure, Identification and Significance in Science and Medicine" (New York and London, 1935).

[3] MacCleod, J., *Bot. Centralbl.*, **29**, 150 (1887).

[4] Baker, H. G., *Ann. Bot.* (N.S.), **12**, 207 (1948).

[5] Lindley, J., "The Genera and Species of Orchidaceous Plants" (London, 1840).

[6] Darwin, C. D., "The Various Contrivances by which Orchids are Fertilised by Insects", 2nd ed. (London, 1882).

[7] Cheeseman, T. F., and Hemsley, W. B., "Illustrations of the New Zealand Flora. Plates drawn by Miss Matilda Smith". Vol. II. (Wellington, N.Z., 1914).

[8] Godfery, M. J., *J. Linn. Soc. Lond.* (*Botany*), **45**, 511 (1922).

[9] Godfery, M. J., "Monograph and Iconograph of Native British Orchidaceæ". Plates by Miss Hilda M. Godfery. (Cambridge, 1933.)

[10] Rafn, C. G., "Entwurf einer Pflanzenphysiologie, aus dem Danischen ubersetzt von J. A. Markussen" (Copenhagen and Leipzig, 1798).

[11] Link, D. H. F., "Grundlehren der Anatomie und Physiologie der Pflenzen" (Göttingen, 1807).

[12] Palla, E., *Ber. d. Deutsch. Bot. Gesellsch.*, **9**, 85 (1891).

[13] Bauer, F. A., *Strelitzia* depicta; or coloured figures of the known species of the genus *Strelitzia* from the drawings in the Banksian Library (London, 1818). (The originals are now bound with Vol. VI (Monocots.) of Bauer's drawings of Kew Garden plants and are housed in the Botanical Library of the British Museum (Natural History).)

[14] Dutrochet, R. J. H., *Gard. Mag.*, **8**, 500 (1832).

THE EIGHTEENTH-CENTURY REVOLUTION IN CHEMISTRY*

By DR. DOUGLAS McKIE
University College, London

ALTHOUGH the isolation and recognition of different kinds of 'air' (or gases, as they were later called) by Black, Cavendish and Priestley played a great part in the eighteenth-century revolution in chemistry, that great change, leading to the foundation of modern chemistry, was brought about through researches on the problems of combustion, the calcination of metals and respiration.

Current theory, when the century opened, regarded combustion and calcination as processes in which phlogiston, a common constituent inflammable principle of all combustibles, including metals, was released from combustibles and metals. A similar explanation was given for respiration.

The first historically significant advance was made by Black in 1755 when he differentiated an 'air' chemically from common air; he called it "fixed air" and showed it to be present in the mild, but not in the caustic, alkalis Later he proved that it was produced in respiration, fermentation and the combustion of charcoal In 1766, Cavendish distinguished another 'air', namely, "inflammable air" (hydrogen), obtained by the action of acids on metals Black had, in fact, already pointed out that this 'air' was different from 'fixed air' For a long time gases, as they were discovered one after another, were regarded as different kinds of air, like common air though changed in properties, but still essentially air

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* Based on three lectures given at the Royal Institution on January 23 and 30, and February 6.

From 1772 onwards the remarkable experimenter, Priestley, isolated seven further 'airs' "nitrous air" (nitric oxide), "marine acid air" (hydrogen chloride), "alkaline air" (ammonia), "vitriolic acid air" (sulphur dioxide), "diminished nitrous air" (nitrous oxide), "nitrous vapour" (nitrogen dioxide) and, most importantly for the advance of chemical theory, "dephlogisticated air" (oxygen) The last he obtained by heating mercury calx in the focus of a burning lens on August 1, 1774, he found that it was insoluble in water and that it greatly enhanced the burning of a candle-flame He obtained it also from red lead

Almost immediately after his isolation of this new 'air', Priestley left England to accompany his patron, Lord Shelburne, on a Continental tour He was in Paris in October 1774, and told Lavoisier and other French chemists of the new 'air' that he had obtained two months previously After his return to England in November 1774, Priestley found (March 1775) that this 'air' was respirable and much better than common air both for respiration and combustion "As I think," he wrote, "I have sufficiently proved, that the fitness of air for respiration depends upon its capacity to receive the *phlogiston* exhaled from the lungs, this species may not improperly be called, *dephlogisticated air* "

Returning to Priestley's meeting with Lavoisier in October 1774, we know that, long before this date, Lavoisier had studied both combustion and respiration His laboratory note-books show that he had experimented on the combustion of phosphorus on September 10, 1772, to find out whether or not it absorbed air in burning, but the entry does not give the result Some weeks later, on October 20, he deposited a note with the secretary of the Paris Academy of Sciences asserting that phosphorus on burning combined with a very large amount of air and thereby increased in weight On November 1 following, he deposited a sealed note at the Academy, stating that both sulphur and phosphorus combined with air on burning and increased in weight, and that the gain in weight of metals on calcination was due to the same cause, while, in the reduction of calces with charcoal, a large volume of air was liberated

Some months later, on February 20, 1773, Lavoisier drew up a long memorandum in his laboratory note-book, envisaging a long series of experiments on the air set free from substances in every kind of chemical change, a series which he foresaw as "destined to bring about a revolution in physics and in chemistry" The first results of his work were published early in 1774 in his "Opuscules physiques et chymiques" Although he had here clearly grasped the idea that metals on calcination combined with 'air', his observation, that the 'air' that was evolved on the reduction of a calx with charcoal was 'fixed air', led him to suppose that it was this species that combined with the metals on calcination He was frequently confused and uncertain at this time sometimes he thought that the metals combined with common air, and at others he considered that they combined with an 'elastic fluid' contained in common air Experiments on the burning of phosphorus gave a maximum reduction of one-fifth of the volume of air exposed, by combination of the phosphorus either with air or "some other elastic fluid contained in it"

On April 14, 1774, he submitted a memoir (read on November 12, 1774) to the Academy on the calcination of lead and tin in sealed vessels The sealed vessels, weighed before and after heating, showed no change in weight, but, when the seals were broken, air was heard to rush in When the vessels were re-weighed after the admission of air, a gain in weight was observed, he reported, in every instance exactly equal to the gain in weight detected in the metal when removed from the vessel and weighed separately The gain in weight of the metal he ascribed to combination with the 'fixable' part of the air, which suggests strongly that he was still thinking in terms of Black's 'fixed air' An account of this work was published during the next month, December, in Rozier's *Observations sur la Physique* (The publication of the annual volume of *Mémoires* of the Academy was usually some years in arrears, and the opportunity of preliminary publication in Rozier's journal was often taken)

A fortnight or so before the reading of this memoir there occurred the meeting with Priestley, at which Lavoisier was informed of the new 'air' isolated on August 1, 1774 In March 1775, Lavoisier, as his note-book shows, prepared Priestley's new 'air' and confirmed its property of enhancing the brilliance of a candle-flame, but he made a further observation, also important in his researches, namely, that it did not precipitate lime-water and therefore that it was not 'fixed air' The immediate result was the reading to the Academy on April 26, 1775, of another memoir, which also, like its forerunner, was printed almost at once in Rozier's journal (May 1775), in this memoir Lavoisier described the production of 'air' by heating calx of mercury, and stated that the product was insoluble in water, did not precipitate lime-water or combine with caustic alkalis or render them mild, was diminished by 'nitrous air' (nitric oxide), could be used to calcine metals, did not asphyxiate animals or extinguish a lighted candle but enlarged its flame in a remarkable way—in short, it had none of the properties of 'fixed air' Lavoisier concluded that what combined with the metals on calcination was the purest part of the air, not, it should be noted, a particular constituent of the air, but the pure air itself.

These two memoirs afterwards appeared in the annual volumes of *Mémoires* of the Academy for 1774 and 1775, but, as the publication of both volumes was delayed until 1778, the two memoirs were revised, the former being returned to the Academy after revision on May 10, 1777, and the latter being read in its new form on August 8, 1778

In its revised form the memoir of 1774 now stated that it was a part of the air that combined with the metals in calcination, while another part did not so combine, and to the former Lavoisier gave the name "salubrious air", while the latter he described as a *mofette*, an asphyxiant, incapable of supporting combustion or respiration, the common air consisting of these two very different 'elastic fluids', the former a little heavier than the latter In the recension of the memoir of 1775, the part of the air which was active in combustion, respiration and in calcination was re-named "eminently respirable air", and 'fixed air' was described as a compound of charcoal and 'eminently respirable air', because charcoal, when heated with calx of mercury, completely disappeared and only mercury and 'fixed air' remained

The new theory of combustion, respiration and calcination thus dates from 1777 later Lavoisier gave to "eminently respirable air" the name 'oxygen' or acidifying principle or element, supposing it to be a constituent of all acids

Lavoisier's views met, however, with little or no acceptance Until 1783, he did not openly criticize the phlogiston theory, restricting himself to showing that his explanations were more in accordance with the facts, but in 1783 he submitted a memoir (published in 1786) to the Academy criticizing the phlogiston theory in detail There was, however, an outstanding difficulty, inexplicable in terms of his theory, but readily explicable in terms of phlogiston, namely, the production of 'inflammable air' when a metal was dissolved in acid The phlogistic explanation was simple a metal was composed of a calx united with phlogiston, and, when the metal was dissolved in acid, its calx combined with the acid to form a salt, while its phlogiston, thus set free, appeared in the form of 'inflammable air', which some chemists regarded as phlogiston itself As for Lavoisier, who looked upon the action between a metal and an acid as a reaction between a metal and the compound of a non-metal with oxygen (such were the acids, in his view), he could obviously offer no explanation of the production of 'inflammable air' in this change

The communication by Blagden to Lavoisier in Paris, in June 1783, of the results of Cavendish's as yet unpublished experiments, in which, by the combustion of 'inflammable air' either in common air or in 'dephlogisticated air', he had obtained water as the product, solved this difficulty On June 24 of that year, in the presence of Blagden and others, Lavoisier made a rough qualitative verification of Cavendish's observation and reported the result next day to the Academy in the names of Laplace and himself On November 12, 1783, he read a memoir to the Academy on further similar experiments, concluding that water was a compound of the two airs, namely, 'inflammable air' and 'dephlogisticated air' The memoir was published next month in Rozier's journal and afterwards (1784) in the Academy's *Mémoires* for 1781 Cavendish had made his experiments in 1781 and had delayed publication of his paper until 1784, as he had in the meantime turned aside to solve the composition of the 'nitrous' (nitric) acid that had fortuitously appeared when he used 'dephlogisticated air' instead of common air Cavendish's explanation was that 'dephlogisticated air' was dephlogisticated water and that 'inflammable air' was phlogisticated water, and that, by the action of the electric spark (used to explode the mixture), the 'airs' were condensed into water It was widely believed at that time that 'airs' contained water We may represent Cavendish's explanation thus:

$$\text{'dephlogisticated air'} + \text{'inflammable air'} \rightarrow (\text{water} - \text{phlogiston}) + (\text{water} + \text{phlogiston}) \rightarrow \text{water}$$

In Cavendish's view, therefore, the water was condensed from both airs, in each of which it was previously present as a component In Lavoisier's view, water was a compound of the two airs He supported his explanation by showing that iron filings decomposed water, giving 'inflammable air' and calx of iron, the latter being produced by the combination with the iron of the 'dephlogisticated air' set free from the water Other verifications followed Cavendish had first shown that the product of the combustion of 'inflammable air' was water, Lavoisier first gave the accepted explanation of the composition of water

Later, in collaboration with others, Lavoisier in the "Méthode de Nomenclature chimique" (1787) set out the system of our modern chemical nomenclature, in which the names of substances indicate their chemical composition, and in 1789 he published his classic "Traité élémentaire de Chimie", expounding his new system of chemistry and containing, among other matters, the first table of the chemical elements (defined as substances that could not be decomposed into any simpler substances) and an assertion of the principle that matter is conserved in chemical change The publication of this great book, which is comparable historically with Newton's "Principia", marked the passing of the older chemistry and the foundation of the modern science

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NEW FELLOWS OF THE ROYAL SOCIETY

At the meeting of the Royal Society held on March 15, the following were elected to the fellowship

Dr C S Beals, Dominion Astronomer, Ottawa, distinguished for his contributions to observational astrophysics, including particularly the study and interpretation of the broadened emission lines in stars with extended atmospheres and of interstellar lines

Brigadier J S K Boyd, director, Wellcome Laboratories of Tropical Medicine, London, distinguished for important contributions to bacteriology and immunology, his researches on the dysentery bacilli, the typhus fevers and tetanus led to great improvements in methods of diagnosis and control measures

Dr D G. Catcheside, reader in plant cytogenetics, University of Cambridge, distinguished for his researches on the cytology and inheritance of plants and animals

Dr A H Cook, assistant director, Brewing Industry Research Foundation, London, distinguished for his researches in organic chemistry, particularly in relation to fungal antibiotics and the synthesis of heterocyclic compounds

Dr S J Folley, head of the Department of Physiology, National Institute for Research in Dairying, distinguished for his researches into the physiology and biochemistry of lactation, and particularly the influence of hormones on milk secretion

Prof H Frohlich, professor of theoretical physics, University of Liverpool, distinguished for his application of quantum theory to the physics of the solid state, including particularly the properties of insulators and the interpretation of superconductivity , he has also made important contributions to the theory of atomic nuclei

Dr Geoffrey Gee, director, British Rubber Producers Research Association , distinguished for his work on the properties of substances of very high molecular weight, especially rubber and rubber-like substances

Prof H A Heilbronn, professor of mathematics, University of Bristol, distinguished for his discoveries in the analytic theory of numbers and, in particular, for his work on the class-number of quadratic fields

Dr G Herzberg, director, Division of Physics, National Research Council, Ottawa , distinguished for his contributions to experimental and theoretical physics and chemistry, in particular for his work on molecular and atomic spectra

Dr J B Hutchinson, director, Central Cotton Research Station, Namulonge, Uganda , distinguished for his genetical studies of the cotton plant, which have led to notable advances in the classification of this genus, and to the theory of the evolution of its species

Dr H R Ing, reader in pharmacological chemistry, University of Oxford , distinguished for his investigations on the chemistry of drugs and the chemical aspects of drug action

Dr David Lack, director, Edward Grey Institute of Field Ornithology, Oxford , distinguished for his studies on the behaviour and evolution of birds, especially the formation of species and races of the finches of the Galapagos Islands

Dr T R R Mann, member of the staff of the Agricultural Research Council , a biochemist distinguished for his researches on carbohydrate and phosphorus metabolism of muscle, moulds and mammalian seminal fluid, and for his studies on metalloprotein enzymes

Dr K A G Mendelssohn, University demonstrator, University of Oxford , distinguished for his work in experimental physics, especially for his investigations on the properties of liquid helium and of the superconducting state

Dr A Neuberger, biochemist, National Institute for Medical Research, London , distinguished for his researches on the biochemistry of amino-acids and proteins

Dr L. B Pfeil, director of research, Mond Nickel Co , Ltd , distinguished for his contributions to metallurgical research on ferrous and non-ferrous metals

Dr J A Prescott, director, Waite Agricultural Research Institute, Adelaide , distinguished for his investigations on the soil types of Australia, their geographical distribution and relation to climate and vegetation

Prof M H L Pryce, Wykeham professor of physics, University of Oxford, distinguished for his work in theoretical physics, in particular quantum mechanics and quantum electrodynamics, and for his contributions to the knowledge of the properties of the solid state at low temperatures

Dr W J Pugh, director, Geological Survey of Great Britain and the Museum of Practical Geology, London , distinguished for his researches on the Ordovician and Silurian rocks of Wales

J A Ratcliffe, reader in physics, University of Cambridge , distinguished for his contributions to the development of the scientific basis for radio communications

Prof T A Stephenson, professor of zoology, University College, Aberystwyth , distinguished for his researches on marine biology, especially on the growth and reproduction of corals and the distribution of animals and plants on the sea-shore

Dr W H Thorpe, lecturer in entomology, University of Cambridge , distinguished for his researches on insect physiology and animal behaviour

Dr P J du Toit, president of the Council for Scientific and Industrial Research, South Africa, formerly director of the South African Veterinary Research Institute, Onderstepoort , distinguished for his contributions to the study of the diseases of animals, especially of domestic cattle, and particularly those due to soil deficiencies and to infections transmitted by ticks

A M Turing, assistant director, Computing Machine Laboratory, University of Manchester , distinguished for his contributions to mathematical logic and, in particular, for his work on computable numbers

Prof A R J P Ubbelohde, professor of chemistry, Queen's University, Belfast , distinguished for his work in physical chemistry with special reference to structural and thermodynamic questions and reaction mechanism

NEWS and VIEWS

Mining at King's College, Newcastle

Prof. Granville Poole

Prof Granville Poole, who is shortly retiring from the Milburn chair of mining at King's College, Newcastle, was appointed to this post in October 1923 in succession to Prof Henry Louis Before going to King's—or Armstrong College as it was then called—he had occupied the chair of mining in the University of Leeds during 1920–23 Previously he had seen extensive service in various posts in the Mines Department at the Home Office and had gained a wide experience in matters relating to spontaneous combustion in coal mines His interest in them has never flagged, and frequently he has been called upon to apply his specialized knowledge to the investigation of colliery explosions He was also supervisor of the Northern Coke Research Committee and the Fuel Survey Committee for Northumberland and Durham In 1924 Prof Granville Poole started the Armstrong College Mining Society, becoming its first president, and has continued to hold this office ever since In 1946 he inaugurated the *King's College Mining Bulletin*, a publication which has a wide circulation to those interested both at home and abroad He is the author of a treatise considered as a standard work on haulage and winding, and has frequently been consulted on this and other aspects of the mechanization of the coal mines in the North He is the present president of the North of England Institute of Mining and Mechanical Engineers, and a member of the Council of the Institution of Mining Engineers

Mr E. L. J. Potts

Mr Edward L J Potts, who has been appointed to succeed Prof Granville Poole, comes from a mining family, being one of four sons, three of whom graduated in mining at King's College, Newcastle. After taking first-class honours, he conducted research into ventilation problems and was awarded the M Sc He possesses the mine surveyor's and first-class manager's certificate of competency and was appointed lecturer in mining in 1940, and reader in 1946, at King's College In addition to practical experience in Great Britain, he has studied mining methods abroad and is at present engaged with Prof Fritzsche, of Aachen, in compiling a treatise on "Horizon Mining" sponsored by the National Coal Board Mr Potts has carried out a considerable amount of research and has many publications His research includes the distribution of stress around underground excavations, using photo-elastic methods, the investigation of air-flow conditions in underground roadways and in mine fan installations, the development of an original design of a circular fluorescent-lighting unit for face and roadway lighting, and the application of anodized aluminium reflectors, and the design and operation of a fine-coal washing system incorporating a paraboloid cone equipped with jets Mr Potts was technical adviser to the Northumberland coal owners at Stage II of the Valuation of Northumberland Collieries under the Coal Mines Nationalization Act He has been appointed mining adviser to the Peterlee Development Corporation, and is conducting subsidence surveys and advising on mining subsidence in relation to the development of a master plan for the new town

International Polarographic Congress in Prague

A meeting of some four hundred workers interested in polarography was held in Prague during February 4–8 Visitors from Poland, Hungary, Roumania and Bulgaria were present The congress was organized by the Centre of Research and Technical Development in Prague, under the presidency of Prof J Heyrovský, director of the Central Institute of Polarography, with Prof R Brdička, director of the Physico-chemical Institute of the Charles University, Prague, as vice-president An evening meeting for visitors, held in the old palace of Sylva Taroucca, preceded the opening of the Congress, which was inaugurated in the large theatre of the Purkyně Medical Institute on February 5 by the Minister of Planning, Dr J Dolanský, and director of the Centre of Research and Technical Development, Prof J Fukátko Dr Dolanský spoke on the cardinal tasks of science in building up socialism, and Prof Fukátko on the role of planning in scientific research Prof J Heyrovský then gave a review entitled "Fundamentals of Polarography" The proceedings of the Congress were divided into eight surveys, each of about an hour's duration, in which modern developments of polarography were summarized, and the discussion of papers submitted to the Congress. The following surveys were given Vl Majer, "Inorganic Analysis", Vl Hanuš, "Polarography of Organic Compounds", P. Zuman, "Organic Analysis", F Šantavý, "Polarography in Biochemistry and Medicine", J Forejt, "Instruments for Oscillographic Polarography", J Heyrovský, "Applications of Oscillographic Polarography", R Brdička, "Kinetics of Electrode Processes in Polarography" Fifty-five communications were presented Reports on the communications and discussions will be published in full in three volumes, of which the first will also contain contributions from abroad not communicated at the Congress, in English, French and German, the second a full bibliography of polarographic papers from 1922 to 1950, and the third actual reports of the meetings Single volumes, which will appear about in April, will be sold to non-members of the Congress

National Central Library: Annual Report for 1949–50

The thirty-fourth annual report of the executive committee of the National Central Library, covering the year ending February 28, 1950 (pp 30, London · National Central Library, 1950), refers to an increase in the Treasury grant-in-aid from £19,000 to £22,500, including a sum of £1,000 to offset the second stage in the discontinuance of the contribution from the Carnegie United Kingdom Trust A satisfactory response was received to the attempt made in the financial year 1946–47 to increase the sum obtained from libraries of research, commercial and industrial organizations not participating in regional systems but making substantial calls on the Library's services Total issues from or through the Library were 96,552 volumes, an increase of nearly three per cent on 1948–49, but the number of volumes issued to university libraries increased by 22 42 per cent to 12,786, while 17,234 volumes were lent by the university libraries to other libraries Volumes issued to the special outlier libraries, which now number 207, increased from 6,732 in 1948–49 to 7,404, and 17,574 books were lent by these outlier libraries, books issued to libraries of government departments, research and industrial organizations increased from 9,405 to 11,903 volumes Some 607 libraries are now co-operating in the regional systems, and they lent 164,152 volumes to other libraries in their own systems and 21,423 volumes to libraries in other regional systems and to non-regional libraries through the National Central Library There was a striking development in international loans, 994 books being lent to twenty-three countries and 420 borrowed from nineteen countries The activities of the British National Book Centre in arranging for the exchange of 'unwanted' books and periodicals between libraries of different types in Great Britain, between libraries in Britain and those in the Dominions and Colonies, and between British and foreign libraries, continued to expand

"Agronomia Angolana"

The third number of "Agronomia Angolana", published annually by the Serviços de Agricultura at Luanda, Portuguese West Africa (C P 1233), was issued in 1950, previous numbers being those for 1948 and 1949. (No 1, pp 204, No 2, pp 263, No 3, pp 176, 20 angolares each) Its aim, as stated by the editor, is the dissemination of information on agricultural investigations in progress at research stations in the Colony of Angola and elsewhere, and to promote exchange of ideas and of current knowledge. Certain articles of a general character are included, such as those describing the scope and programmes of work at individual agricultural experimental stations, and developments in the Colony's agriculture Original papers are published on a variety of topics, including methods adopted in plant breeding, aspects of fruit growing, regional pedology and meteorology, organic manuring, mechanization, forestry, selective weed-killers, and economic and agricultural botany The publication is designed mainly for circulation to scientific institutions, its subject-matter and format are of a high standard, and most papers have reasonably good summaries in French and English, but many of them lack bibliographical references To cater for growers, "Agronomia Angolana" has established an extension service which will produce bulletins and leaflets for distribution to growers, incorporating the relevant information in a more popular form

Collection of Bygone Agricultural Implements

The collecting of early agricultural implements is an imperative necessity at the present time if any of the fast-disappearing types are to be preserved for posterity Many museums are engaged in this important task, and the Gloucester Folk Museum, housed in Bishop Hooper's Lodging, in addition to collecting and displaying such material, has issued a handy and authoritative guide to its agricultural collections, entitled "Guide to the Collection of Bygone Agricultural Implements" (pp 20+4 plates, Gloucester Folk Museum, 1950; 9*d*) The material is appropriately grouped under the operations of ploughing, sowing and cultivation, haymaking and harvesting, ricking, thatching and threshing, with an added section for certain miscellaneous farm implements Each section is prefaced by some useful general remarks on the subject, written by J N Taylor, the curator

Archives of Biochemistry and Biophysics

Beginning with Vol 31, No 1 (March 1951), the title of *Archives of Biochemistry* has been altered to *Archives of Biochemistry and Biophysics* This change reflects the ever-increasing use of physical methods in biochemistry and is consequent upon the recent decision of the editors to consider, in addition to established biochemical topics, communications in the fields of virus research, radiation effects on living matter, macromolecular biology and chemistry, studies of the application of radioactive indicators, and the physics of biological systems The editorial board has also been enlarged and includes the following new members Drs E Newton Harvey, E C Pollard and R. W G Wyckoff.

Science in General Education

The Harvard Summer School of Arts, Sciences and Education is organizing a conference on "Science in General Education" to be held during July 9–11 at Harvard University, Cambridge, Mass A series of three evening meetings, open to the public, are being arranged on "Science and Society", "Science and Philosophy" and "Science and History", which will be directed by Dr K. T Compton (Massachusetts Institute of Technology), Prof P Le Corbeiller (Harvard) and Prof I Bernard Cohen (Harvard), respectively Each meeting will consist of two prepared papers, thirty to forty minutes in length, followed by a discussion by two commentators, of about fifteen minutes each On the afternoon following each meeting, a number of invited guests will meet privately for a further discussion, based on the talks of the previous day These guests, who will number about sixty to eighty, will include leading figures in contemporary science, both pure and applied, some government representatives (both military and non-military) connected with science, a number of educational leaders and teachers, and some scholars or specialists, a few will be from Europe, and from Canada and Mexico These private discussions will thus provide an opportunity for bringing together a number of different groups who, in one way or another, are concerned with science or with its effects on human affairs Correspondence referring to the School should be sent to the Director, Harvard University Summer School of Arts and Sciences and of Education, 2 Weld Hall, Cambridge 38, Mass

University of London

Mr M B Donald has been appointed to the Ramsay Memorial chair of chemical engineering tenable at University College from October 1 The degree of D Sc has been conferred on the following Mr C B Allsopp, appointed teacher at Guy's Hospital Medical School, Mr Eugen Glueckauf, Imperial College of Science and Technology, Mr W C J Ross, Imperial College of Science and Technology

Engineering-Apprentice Scholarships for British Commonwealth Graduates

The BRUSH ABOE Group of companies has recently instituted a new scholarship scheme whereby honours graduates in engineering from overseas countries of the British Commonwealth can undertake a two-year practical apprenticeship, studying the products and methods of the Group The first year will provide general instruction in basic manufacturing processes, after which more specialized topics will be studied The factories concerned are The Brush Electrical Engineering Co, Ltd, Loughborough, Leics, Mirrlees, Bickerton and Day, Ltd, near Stockport, Cheshire, J and H McLaren, Ltd, Leeds 10, Petters, Ltd, Staines, Middx, Henry Meadows, Ltd, Fallings Park, Wolverhampton, and the National Gas and Oil Engine Co, Ltd, Ashton-under-Lyne Apprentices will be provided with a free return passage and will be paid the standard wage-rate (at present £6 9*s* 6*d* a week) Further details can be obtained from BRUSH ABOE Group Services, Ltd, of Duke's Court, Duke Street, London, S W 1

Announcements

Mr P A Wells, director of education to the International Wool Secretariat, has been appointed deputy secretary and secretary-elect of the Royal Sanitary Institute

The annual conference of the Textile Institute will be held this year in Brighton during May 21–25 Thirty-six papers will be read, the general theme of the conference being "Textiles their Past, Present and Future" Further details can be obtained from the Institute at 16 St Mary's Parsonage, Manchester 3

Dr E Clar, lecturer in chemistry in the University of Glasgow, has been awarded one of the prizes offered by the Spanish Government for a paper, on the absorption spectra of aromatic hydrocarbons at low temperatures, read at the Twenty-second Congress on Industrial Chemistry

Erratum In the review of "Chemistry and Uses of Insecticides" by Dr E R de Ong (*Nature*, 167, 211, Feb 10, 1951) the price is quoted as 36*s* net Owing to devaluation, the price has now been raised to 54*s* net

PLASTICITY OF MAMMALIAN MONOSYNAPTIC REFLEXES

By Prof J C Eccles, F R S, and Dr A. K. McIntyre
Department of Physiology, University of Otago, Dunedin, New Zealand

PLASTICITY in the central nervous system, that is, the ability of individual synaptic junctions to respond to use and disuse by appropriate changes in transmissive efficacy, is frequently postulated or implied in discussions on the mechanisms underlying the phenomena of learning and memory[1,2] Little concrete evidence has, however, been brought forward in support of this concept, possibly because of the great technical difficulties of studying quantitatively synaptic transmission in the higher levels of the nervous system, where the postulated property of plasticity may reasonably be expected to reach its fullest development. In the case of simpler spinal and brain-stem reflex-levels, some investigations have indicated a considerable measure of reflex remodelling after such procedures as nerve or muscle transposition[3] , but, on critical examination[4], the balance of evidence tends towards the view that, in mammals, functional state as well as spatial pattern remain relatively constant at such elementary reflex levels Moreover, precise investigations of transmission in the simplest (monosynaptic) reflex arcs have not, until lately, revealed changes in functional state lasting for more than about one-hundredth of a second[5–7] Recently, however, more enduring changes have been shown to take place in monosynaptic reflex arcs, the effectiveness of a given presynaptic volley becoming greatly enhanced for a period of several minutes after an intensive burst of repetitive firing of the same presynaptic fibres, a phenomenon that has been called post-tetanic potentiation[8,9] It can be argued that this relatively enduring change in synaptic functional state indicates the existence of an element of plasticity even at this level of nervous function—the simplest possible reflex arc[9] Accordingly, we have studied the effects of *disuse* on such reflex arcs, with the object of determining whether prolonged inactivity of presynaptic paths leads to a deficiency of synaptic excitatory action, a deficiency which, if reversible by activity, would strongly support the concept of plasticity at the simplest reflex-level

Prolonged and total disuse can be most effectively secured by severing the dorsal roots just distal to their ganglia, thus retaining functional continuity between parent cell bodies and the central projections within the spinal cord of their silenced fibres This operation was done with aseptic precautions for two or three of the dorsal roots innervating the cat's hind limb (lumbar 6 and 7 and sacral 1), great care being taken to minimize injury to the ganglia and to the subjacent ventral roots All operations were done entirely extra-durally so that the delicate intra-dural segments of the spinal roots did not suffer damage by post-operative scarring The roots of the other side were left intact as controls , but in some experiments they were subjected to a dummy operation, only the cutting of the dorsal roots being omitted Afterwards the animals were exercised daily by walking in a simple treadmill, and 34–40 days post-operatively under nembutal anæsthesia the spinal cord was divided in the lower thoracic region and the reflex activity of the caudal stump was systematically investigated on both sides Reflex responses were set up by single dorsal root volleys (maximal for the large group-I afferent fibres), and were recorded monophasically either from nerves to various limb muscles (both flexors and extensors to digits, ankle and knee) or from one or other of the isolated ventral roots. In addition, all reflex responses were observed after post-tetanic potentiation[8,9] Every precaution was taken to enhance the significance of the comparison between the two sides extreme care in dissection and manipulation , identical placing of recording electrodes on the corresponding nerves and roots , multiple records of each reflex so that mean values for the two sides could be compared , temporal juxtaposition (and often alternating sequence) of each series of investigations on the two sides , subsequent histological examination of the nerves and roots on the two sides

Our experiments have given convincing evidence that the operative section greatly diminished the reflex effectiveness of dorsal root volleys For example, a volley in the combined L_7 and S_1 roots failed to evoke a monosynaptic reflex discharge to the gastrocnemius muscle (Fig 1*a*, *L*) in contrast to the normal control side (Fig 1*a*, *R*) Nevertheless, quite a large monosynaptic reflex was evoked during conditioning by post-tetanic potentiation, though it was still well below the control side similarly potentiated (Figs 1*a*, *L* and *R*) Likewise, there was merely a trace of monosynaptic discharge to the biceps-semitendinosus muscles, which was greatly potentiated (Fig 1*b*, *L*), though only to about one-quarter of the potentiated size on the control side (lowest record, Fig 1*b*, *R*) Later polysynaptic flexor reflex discharges are prominent in all records of Fig 1*b*, having latent periods from 3 3 to at least 10 msec

Figs 1*a* and *b* illustrate the asymmetry that was observed in twenty-five series of investigations on reflex discharges into muscle nerves Five of these experimental series resembled Fig 1*b* in that unconditioned dorsal root volleys evoked monosynaptic reflexes that differed from the control side merely by their much smaller size (cf Fig 2, open circles). Only two series were exceptional, the reflex responses being not significantly different on the two sides. Relatively larger reflexes were never evoked by volleys in the operatively sectioned roots In eleven series of investigations, we have recorded the reflex responses from a single isolated ventral root corresponding segmentally to the stimulated dorsal root Uniformly the monosynaptic reflexes have been much smaller for the operatively sectioned roots, being often absent, and this disparity has been maintained during post-tetanic potentiation

The question at once arises To what extent can reflex deficiency on the operated side be attributed to changes in the presynaptic pathways other than mere absence of the normal impulse barrage ? Two such possible causes have been revealed by subsequent histological examination of the appropriate dorsal roots stained with osmic acid

First, in many experiments, there was some post-operative degeneration of fibres in the intradural path of one or other of the severed dorsal roots,

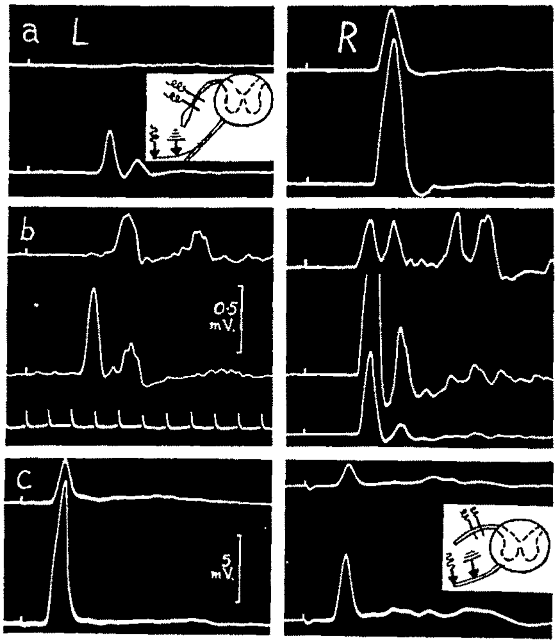

Fig 1 Reflex discharges in one experiment in response to single dorsal root volleys maximal for group I fibres, the left and right sides being marked *L* and *R* The left L$_7$ and S$_1$ dorsal roots had been severed just distal to the ganglion forty days previously In (*a*) upper records show reflex discharge into gastrocnemius nerve evoked by a volley in L$_7$ and S$_1$ dorsal roots (see inset), being zero for *L*, but large in control *R*, lower records, responses after same degree of post-tetanic conditioning for *L* and *R* Curves (*b*) are as for (*a*), but reflex discharges into the conjoint biceps-semitendinosus nerve With unconditioned *L* there is a minute monosynaptic discharge (increased by conditioning to a large spike) and large later polysynaptic discharges of flexor reflex Post-tetanic conditioning so greatly increased the *R* monosynaptic spike that it was deflected off the screen, and the lowest record gives the response at ¼ amplification Note with *R* the later polysynaptic discharges of flexor reflex (*c*) shows single volleys in L$_6$ dorsal root and recording from corresponding L$_6$ ventral root (see inset diagram) Time scale given in milliseconds for all records Except for lowest (*b*) *R* record, the potential scale is as shown for all (*a*) and (*b*) records Potential scale as shown for all (*c*) records. All illustrations chosen from several closely similar records

presumably the result of ganglionic injury, either at operation, or afterwards through post-operative scarring, which was often considerable in the immediate vicinity of the ganglia However, in experiments involving operated roots in which no loss of fibres was detectable, the same reflex deficiency was observed, for example, the reflexes illustrated in Figs 1*a* and *b* Thus it appears unlikely that loss of dorsal root fibres in other experiments can be regarded as more than a contributory cause of the reflex disparity observed

Secondly, even when no actual loss of fibres was detectable, those in the operated dorsal roots were slightly smaller (mean, about 90 per cent for the largest fibres) than fibres in the corresponding normal roots of the opposite side In keeping with this, conduction velocity was about 10–15 per cent lower in the dorsal roots silenced by operation Presumably this shrinkage is analogous to axonal shrinkage in the central stump of a regenerating nerve, and may be attributable to a diminished turgor consequent on regenerative outgrowth[10-12] Though it seems improbable that shrinkage of this order would be entirely responsible for the usual large depression of monosynaptic reflex responses (cf Figs 1*a* and *b*), it is not possible directly to refute the suggestion that the synaptic knobs shrink more than the main axonal shafts from which they spring, their depressed reflex excitatory power being thus explained

However, two observations suggest that the reflex disparity observed in these experiments carries a wider implication than if it were caused merely by shrinkage attributable to regenerative outgrowth

The first of these observations is that the dorsal root immediately rostral to those operatively divided had a much greater reflex effectiveness than its companion on the normal side In all five experiments where it was tested, the reflex spike discharge into the corresponding ventral root was significantly larger (from about twice upwards) than on the control side, and this difference was maintained during post-tetanic potentiation (Figs 1*c*, *L* and *R*) This may reasonably be attributed to the development of some compensatory reaction to the operative disability With operative section of L$_7$ and S$_1$ dorsal roots, the relative enhanced reflex discharge from L$_6$ dorsal root was always found in the nerves to semimembranosus (three experiments) and to biceps-semitendinosus (two experiments), but there was little or no asymmetry in the discharges to the muscles supplied by the deep peroneal nerve With L$_6$ and L$_7$ root section the compensatory reaction was observed with L$_5$ dorsal roots, which gave, however, symmetrical reflexes when next but one above the operative lesion The simplest explanation of this compensatory reaction is that the operative disability has thrown more mechanical stress on the remaining stretch receptors of any partially de-afferented group of synergic muscles There would thereby be produced an increased monosynaptic bombardment of motoneurones through the dorsal root immediately adjacent to those severed, the increased usage giving rise to enhanced synaptic excitatory effectiveness

The second observation relates to the possibility that an intense but brief prototype of such an effect is already known in post-tetanic potentiation[8,9] It has been argued that this potentiation is most probably explained as a changed spatial relationship which gives more effective synaptic transmission, for example, the synaptic knobs may become larger or more closely apposed to the post-synaptic membrane[9] With the operatively severed roots, post-tetanic potentiation has produced a remarkable increase in monosynaptic excitation (Figs 1*a*, *L*, and 1*b*, *L*), but, in addition, preliminary observations disclosed two special features After a standard conditioning tetanus of 6,000 volleys at 400 a second the time course of the potentiation was slower than on the control side, the summit being later (18–40 sec as against 8–14), and the decay therefrom much more prolonged (Fig 2) Furthermore, after the first conditioning tetanus there was an enduring increase in size of the monosynaptic reflex (Fig 2, open circles and subsequent test shown by filled circles) It would appear that conditioning by the intense period of activity effected a partial restoration of the operative disability, as shown by the residual level of potentiation following the first conditioning tetanus (open circles beyond 400 sec in Fig. 2) (*Note added in proof*. These preliminary results have been fully confirmed, the residual potentiation persisting for many hours)

Thus we are introduced to the concept that activity enhances the functional effectiveness of synapses over a much longer period than the several minutes of ordinary post-tetanic potentiation, though it must be realized that there is as yet no direct evidence to relate these two causes of enhanced function Nevertheless, it may be postulated that disuse is a probable cause of the defective monosynaptic excitatory action of volleys in our operatively severed roots, for no impulses will have passed along those roots during the post-operative period of five weeks or so Such an explanation implies that the normal level of synaptic activation by discharge of stretch receptors ordinarily maintains the excitatory effectiveness of the monosynaptic reflex path

In conclusion, it can be stated that in the simplest mammalian reflex (the monosynaptic myotatic reflex) direct experimental evidence has been obtained in support of the hypothesis that usage leads to increased functional efficiency of synapses and disuse to defective function The plasticity that has been postulated for higher nerve centres in explanation of conditioned reflexes[1,2] and of memory would appear to be an important attribute even of the synapses of the simplest reflex pathway An opportunity is thus provided for precise systematic study of plasticity.

It has been suggested that learning processes, for example, memory and conditioned reflexes, can be attributed to specific dynamic patterns created by impulses circulating continuously in closed self-re-exciting chains of neurones[13,14] Repetitive activity of this kind doubtless accounts for functional changes of brief duration, but raises grave difficulties when applied to enduring memories or conditioned reflexes[2,14] The existence of plastic changes at synapses, as demonstrated in the monosynaptic reflex arc, would remove the necessity for making the improbable postulate of enduring dynamic patterns of circulating impulses, and would provide experimental evidence for an explanation based on patterned changes in synaptic efficacy, possibly of a morphological character[1,2] Such an explanation, however, presupposes that these enduring plastic changes are initially brought about, and are susceptible to reinforcement, by barrages of impulses occurring during temporary phases of patterned re-excitatory activity.

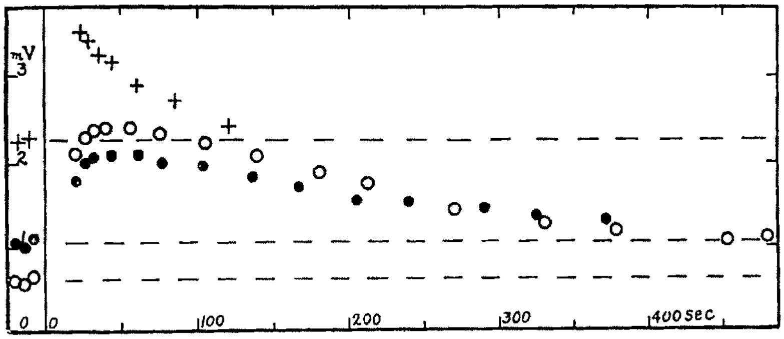

Fig 2 Time course of post-tetanic potentiation (6,000 volleys at 400 a sec) of monosynaptic reflex discharges into gastrocnemius nerve in response to single volleys in L_7 dorsal root L_6, L_7 and L_8 roots on left side were severed just distally to ganglion forty days previously Ordinates, sizes of reflex spikes, abscissæ, testing intervals in seconds after onset of conditioning tetanus Crosses show responses on control R side, open circles on operated L side Preconditioned spikes are plotted in same convention to left of vertical line at zero time, the horizontal broken lines showing mean spike voltages at respective control-levels Note that to left of the zero time-line the open circles plot preconditioned spikes before any dorsal root tetanization, that is, after a complete quiescence of forty days, while afterwards the open circles give the response to the first conditioning tetanus Filled circles show repetition of the L series several hours later

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NATIONAL PHYSICAL LABORATORY OF INDIA

OF the eleven national laboratories planned by the Council for Scientific and Industrial Research, India, the National Physical has very appropriately been located in Delhi itself, the seat of the Union Government Unlike some of the other national laboratories specializing in problems peculiar to particular industries and therefore of greater interest to some regions than to others, the National Physical Laboratory is concerned with basic fundamental work, further, this Laboratory is expected to provide the standards of length, mass, etc, which will be given statutory acceptance, and is therefore of peculiar importance to the State

An account of the plans for this Laboratory appeared in *Nature* of February 8, 1947, soon after its foundation stone had been laid by Mr Jawaharlal Nehru The Laboratory was inaugurated by the late Sardar Vallabhbhai Patel, Deputy Prime Minister, on January 21, 1950

The Laboratory now functions in an imposing building, carefully planned for its purpose The architects visited leading foreign laboratories of similar character, and an assistant director spent a good deal of time making a detailed study of the National Physical Laboratory at Teddington On the architectural side, the Delhi institution has borrowed certain features from the R C A and Bell Telephone Laboratories in the United States, in its functions its two main sources of inspiration have been the National Physical Laboratory at Teddington and the National Bureau of Standards, Washington

The Laboratory's work was originally planned in nine Divisions (1) Weights and Measures, (2) Applied Mechanics and Materials, (3) Heat and Power, (4) Optics, (5) Electricity, (6) Electronics and Sound, (7) Building and Housing Research. (8)

Hydraulic Research, (9) Analytical Chemistry. To these nine Divisions of the original plan, a tenth has been added which concerns itself with industrial physics Meanwhile, for building and housing research a separate national laboratory at Roorkee has been decided upon

The National Physical Laboratory has a spacious site, about sixty-six acres in area, and is situated next to a great centre of scientific research, the Agricultural Research Institute The National Physical Laboratory buildings already cover 150,000 sq ft and are not yet completed The laboratories, workshops, library and administrative rooms were naturally given precedence The lecture theatre is now ready and a cafeteria nearly so Social amenities are not being neglected The National Physical Laboratory can well feel proud of its modern and noble building, and the first impression on the considerable number of visitors that it attracts is an excellent one The rooms in the main building are of adjustable length in steps of 6-ft units and are air-conditioned The *L*-shaped basement, with its larger limb 590 ft long, serves as a store as well as a tunnel for protected services , these go to every room in the Laboratory, not disfiguring the walls and corridors and yet eliminating the necessity of having to dig in to the walls and floors when new service lines have to be laid

Sir K S Krishnan, who was associated with Sir C V Raman's discovery of the Raman effect, is director of the Laboratory and is ably assisted by six assistant directors Besides metrological work and work connected with the maintenance of standards, fundamental research in various sections is being carried on, including that on supersonics The Laboratory is the only one in India equipped with an electron microscope The Laboratory was fortunate in getting at a nominal price very valuable equipment for its excellent workshop, where it may be possible to make a large variety of instruments needed in its different sections Surplus war-stores have been useful, and the Indian scientific liaison officer in London made an excellent selection of items from such disposal sales in Great Britain The Laboratory is already interesting itself in applied research, and new processes for printing inks using new ingredients perfected by its workers have gone through the necessary laboratory tests, and are entering on the commercial stage in the Laboratory itself

The inaugural ceremony was attended by leading men of science from many countries, who went to Delhi after participating in the Indian Science Congress session in Poona, and by Mr C Rajagopalachari (then Governor-General of the Indian Dominion), who presided, Mr Jawaharlal Nehru, Dr S P Mookerjee (at that time Minister for Industries and President of the Council for Scientific and Industrial Research), and Sardar Vallabhbhai Patel, who declared the Laboratory open Great appreciation was expressed of the devoted work done by Sir Shanti Swarup Bhatnagar, director of the Council, and by Dr K N Mathur, assistant director for planning, and there was general rejoicing over the choice of Sir K S Krishnan as director of the Laboratory Speaking of Sir Shanti Bhatnagar, Mr Nehru said that "this large programme of building the national laboratories would never have gone as far ahead as it has if Dr Bhatnagar had not been in charge of them" He also paid tribute to Sir K S Krishnan "It will be difficult," he said, "to find a shyer and more modest man, and yet those who know him know that under that shyness and modest exterior there is a depth and profundity of learning, and it has been a particularly good fortune for us to have him as our Director"

Sir Shanti Bhatnagar, in his address, gave a history of the planning of the National Physical Laboratory since the idea was conceived in 1941, and spoke of its scope and possibilities Both he and Sir K S Krishnan referred to the need for "large-scale specialized organizations for scientific research" and for "team-work" Elaborating on this aspect, Sir K S Krishnan observed "It was not so long ago that we used to speak of the genius in the garret, not so much with a guilty sense of our neglect of values, but almost as though it were the proper atmosphere for genius to flourish in A story is told of a great past president of the Royal Society that when a visitor from the Continent wished to see his laboratory, he requested him to be seated in the drawing-room and had the laboratory brought to him on a tray Many great scientists have grown under, and lent enchantment to, this tradition, which has since been called, with some appropriateness, the 'string-and-sealing-wax tradition' Faraday, the Curies, Thomson, Rutherford and Raman But for the majority of us the Muse of Science has become a little too sophisticated to be wooed under such simple surroundings Large laboratories, liberal equipment, and enthusiastic teams are the least that seem to satisfy her—the more so when science has to be applied to industry, as it will be, in these Laboratories "

Dr H. J Bhabha, director of the Tata Institute of Fundamental Research, Bombay, also stressed this point As a member of the Planning Committee for the Laboratory, he recalled that "the Committee endeavoured to plan the Laboratory on the most modern lines and to make its scope, design and equipment such as would place it among the best laboratories of its kind in the world to-day It is not often in human affairs that the realization of an idea exceeds the dreams of those who planned it, but I think I would be right in saying that none of the members of the Planning Committee of this Laboratory could have fully realized what a magnificent Laboratory it would become "

Sir Robert Robinson, at the time president of the Royal Society, referred with "justifiable pride" to the achievements of the National Physical Laboratory in Britain, which was due to celebrate in a few days its fiftieth birthday, and conveyed to its new-born sister the warmest good wishes on behalf of the Council of the Royal Society and of the governing body of the National Physical Laboratory at Teddington Greetings were conveyed also by Prof J D Bernal, professor of physics in Birkbeck College, University of London, and a member of the General Board of the National Physical Laboratory, who in the course of his address observed "Money spent on science is money saved Science is economy This economy, however, can only be realized if the people feel and have reason for feeling that the work of science and industry is for the common welfare and not diverted to the service of private profit and war "

Prof P V Auger, speaking as director of the Natural Sciences Section of Unesco, and as professor in the Faculty of Science, University of Paris, offered the warmest congratulations on the occasion, and said of the new institution "This is no small pearl, but rather a big diamond like the Koh-i-Noor of the history of this country" The greetings of the scientific men of the U S S R were conveyed by Prof W D Englehardt Prof D E H Rydbeck, of the Chalmers Institute of Technology, Sweden, expressed the hope that under the scientific and spiritual leadership of Sir K S Krishnan the new institution would work in the spirit of Tagore and Gandhi, and show the world that "even in the times of tremendous technical and scientific developments ahead of us, it will be possible to develop and maintain a non-violent form of society with no human exploitation".

It was particularly appropriate that Dr E U Condon, of the National Bureau of Standards, Washington, was present on the occasion, as the National Physical Laboratory in its scope will very much take after the Washington Bureau Dr Condon pledged hearty co-operation between Indian and American men of science, "and in particular between our sister institutions, the National Physical Laboratory of India and the National Bureau of Standards of U S A "

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN January of 1947 the faculty of the Massachusetts Institute of Technology appointed a committee to review the state of education at the Institute* The committee was instructed to re-examine principles of education that had served as a guide to academic policy at the Institute for almost ninety years and to determine whether they were applicable to the conditions of a new era emerging from the social upheaval and the disasters of war

The study lasted more than two years and, since the members of the committee believed that major revision should be undertaken only after a basic re-evaluation of the educational philosophy on which the Institute is based, little attention was paid to details of curricula The committee did, however, examine the concept of professional education upon which the Institute was founded and re-assessed the way of teaching The task, therefore, was to determine whether the Institute should alter the direction of its effort or apply its methods in new ways or to new areas

It may be asked why there was felt to be the need of critical appraisal at a time when the Institute was conspicuously healthy and vigorous ? In formulating questions to guide the deliberations of the committee, the Faculty expressed concern about the educational implications of changes that have taken place both in the Institute and in the society that it serves, its studies have revealed apprehensiveness among the staff and alumni that, in an exciting inflationary atmosphere when money was easy and physical expansion tempting members of the Institute may have yielded uncritically to temporary pressures and lost sight of long-range educational goals The committee also feared that the Institute was adhering to a kind of education that proved successful a generation ago without taking into account significant changes that may have made this kind of education obsolete

For these reasons the committee recommended that the Institute should boldly undertake new experiments in education and new explorations into the unknown, withdrawing at the same time from ventures in which its leadership is no longer required They also made recommendations as to how the Institute might accomplish these purposes most effectively

Among these were the important points that William Barton Rogers's original concept of higher education with a scientific and technical basis on which the Institute is based, of learning by doing, and of the value of an integrated professional and liberal education, are important guiding principles for its educational policy to-day These principles, however, must be interpreted broadly and applied with full cognizance of the many changes which have taken place since Rogers founded the Institute in 1865 The committee recognized, too, that the educational programme at the Institute has at times veered unduly towards the vocational and recommended that such tendencies be avoided in future by the adoption and effective application of certain policies and procedures which are elaborated in its Report Further, despite the fact that the Institute's long period of emphasis upon engineering education at the expense of science, the humanities and social sciences, and perhaps even architecture, was followed by an awakening to a broader mission in the 1930's, the committee felt that the Institute has not yet begun to exploit to the full its opportunities in these other fields

As a result of the Second World War the rapid growth of the Institute has given rise to dangers of over-expansion, and the committee recommended that a serious effort be made to stabilize the overall size of the Institute within limits that would avoid purposeless dissipation of abilities and resources

In addition, many factors, including expansion of knowledge and enlarged support of research and development activities, have led to pre-occupation with graduate education at the sacrifice of attention to the undergraduate programme The committee re-affirmed its belief in Rogers's concept of undergraduate professional education and advocated the establishment of an appropriate balance by strengthening and re-vitalizing undergraduate education, this should not be done by curtailing the achievements of the graduate school The four-year undergraduate professional education has special advantages to-day, either as direct preparation for a career or for advanced work in science or technology, no advantage would be gained in a gradual lengthening of the undergraduate curriculum to five or six years

The committee also believes that a scientific and technical environment affords special opportunities for many individuals who wish to acquire a broad cultural education and a full appreciation of modern trends in society The fundamental problem of technological institutions is that of developing sufficient strength in the social sciences and humanities, and the Institute is advised to take advantage of new opportunities to give the social sciences and humanities full professional status, there is a strong recommendation for the immediate establishment of a school of humanities and social sciences

The growth of sponsored research at the Institute has provided invaluable opportunities for realizing the educational advantages of an active research and development programme, it has also led to possibilities of indiscriminate participation in activities of questionable creative value, of dissipation of staff effort in administration, and of dependence upon unreliable short-range financial support The committee recommended that greater emphasis be given to periodic and realistic evaluations of all aspects of sponsored research in relation to the educational programme

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* Report of the Committee on Educational Survey to the Faculty of the Massachusetts Institute of Technology Pp vii+148 (Cambridge, Mass Technology Press of the Massachusetts Institute of Technology 1949)

It was also appreciated that social trends towards a broader base of higher education and financial trends toward decreased endowment incomes pose problems for the Institute no less than for other private institutions, and that, in future, the primary goal of private institutions should be to provide limited groups with useful kinds of education not readily duplicated elsewhere It is recommended, therefore, that the Institute limits its educational efforts to fields in which it clearly excels and that it should continue to give special emphasis to the pioneering of new ventures in which its leadership could be of distinct value to the community and the nation The four fields of engineering, science, architecture and planning, and the humanities and social sciences, would be the most appropriate for education and research at the Institute, and the committee believes that the Institute is now in a position to make outstanding contributions to education and the advancement of knowledge in each of these four fields A general strengthening of the school structure is recommended

The report also contains details of recommendations and syllabuses drawn up by a committee on general education, as well as proposals for strengthening the physical and intellectual environment of the staff and the Institute.

SOCIAL SCIENCE RESEARCH IN SARAWAK

A RECENT report by Dr E. R Leach on "Social Science Research in Sarawak"* is the outcome of a short preliminary study undertaken to prepare the way for a more comprehensive and penetrating "Social–Economic Survey of Sarawak", which, too, is to be sponsored by the Colonial Social Science Research Council. Although the main objective of this short report is stated to be to determine "the requirements of scientific staff and finance", much more attention has been quite rightly paid to a general reconnaissance of the physical and human resources of the territory, and the problems which appear most tempting to the social anthropologist A programme of work is outlined as a result, which is of interest both to the administrator 'on the spot', who is necessarily absorbed in day-to-day affairs, and to the anthropologist, whose primary interest is the advancement of his science It is to be hoped that it will be implemented without delay

The projects contained in this programme are undoubtedly of much theoretical interest A fair sample is the Melanau Sago Project, under which it is proposed to study a community engaged on the production of sago by traditional methods, this is to be extended to include the study of the process of social transition from pagan to Moslem organization, and the changes in class structure resulting from modern political and economic conditions in a traditionally class-stratified society The project is therefore both comprehensive and penetrating, the scientific interest is plainly apparent, and its utility is evident from the fact that it will throw light on the producers' end of the Chinese trade and marketing organization, and on the influence of Christian missions on the relations between pagans and Moslems in Melanau society

The pity of it is that all this work was not done thirty years ago, when the political and social climate was much more favourable and the time-factor was not of the overwhelming importance that it has assumed to-day Leisurely study of the 'native' is surely something that will prove to be much more typical of the first half of the twentieth century than the second Our contemporary world is overshadowed by the political consequences of the rise of nationalism in all the under-developed territories, and the social consequences of the rapid growth of population in them These problems appear as living issues at many points in the report, it must be regretted that the author did not consider himself to be more directly concerned with them None of the research projects has a sufficiently close bearing on them to justify the expectation that they can be relied on to any great extent to assist in their solution at any time in the near future Such "purely political" matters as sedition "hardly concern" the author, changes in the attitudes and ways of life of European residents in Sarawak are considered to be "plainly quite outside the scope" of the report. This conclusion ignores the fact that it is the relationship between the peoples of Sarawak and the outside world which is the most critical factor in their social lives to-day, the rigid limits which the author has placed on his responsibilities and his interests can only be regarded as a cause for concern. The time is now long past when it first became evident that the disruptive forces latent in all Colonial societies must be brought under control, and that ways and means of understanding them must be discovered before this can be done. The pace of political and social change is steadily quickening, and a new note of urgency is required in reports of this kind.

EDUCATION AND TRAINING OF ELECTRICAL TECHNICIANS

AT the ordinary meeting of the Institution of Electrical Engineers, held on November 2, 1950, Sir Arthur Fleming presented a report entitled "The Education and Training of Electrical Technicians"* This report is the work of a joint committee set up by the British Electrical and Allied Manufacturers' Association, the Council of the Institution of Electrical Engineers, and the Radio Industry Council

It will be recalled that the Institution of Electrical Engineers has already published reports dealing with the education and training of professional electrical engineers In these earlier reports mention was made of the special needs of the members of an important section of the technical personnel of the electrical industry who, for purposes of classification, had been termed technicians The present report attempts to specify the nature and scope of the activities of the technician and puts forward recommendations for his theoretical and practical training

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* Colonial Office Colonial Research Studies, No 1 Social Science Research in Sarawak; a Report on the Possibilities of a Social Economic Survey of Sarawak presented to the Colonial Social Science Research Council By Dr E R Leach Pp ii+93 (London H.M. Stationery Office, 1950) 8s 6d net

* The Education and Training of Electrical Technicians Pp 32. (London Institution of Electrical Engineers, 1950) 1s

The report defines an electrical technician in the following terms "An electrical technician is a person who carries out in a responsible manner approved techniques which are *either* common knowledge amongst those who are technically expert in his branch of industry *or* specially prescribed by professional electrical engineers These techniques are not those of the craftsman, though they may involve manual skill, in many cases they include the skilled use of delicate and complicated instruments and may also require the intelligent and accurate use of approved methods of calculation They involve practical experience of some limited branch of electrical engineering combined with the ability to complete the details of a project using well-established practice To become an electrical technician a person must have received a technical education up to a standard at least, and preferably beyond, that of the Ordinary National Certificate in electrical engineering, and in addition must have had training and experience in the particular sphere of electrical engineering in which he is to work "

It is scarcely necessary to emphasize that such a definition embraces a technically important and numerically large section of the electrical industry At an early stage in the report it is stated that the inquiries upon which it is based "have revealed two main facts First, that the status of electrical technicians is not nearly so well defined, nor the importance of their systematic training so fully appreciated, as is the case with professional electrical engineers on the one hand or with craftsmen on the other Professional engineers have been trained for several generations by a system originating in pupilage, while craft training has its roots in medieval apprenticeship, but there is no well-established tradition of training for intermediate occupations "

After listing a typical range of occupations commonly followed by the electrical technician and giving a number of illustrative examples, the report proceeds to a consideration of the qualifications which he needs and to the educational provisions required to meet them It is considered that, for most technicians, an Ordinary National Certificate course will provide a suitable theoretical foundation, but some reduction in the standard of mathematics normally required may be desirable Beyond the stage of the National Certificate, courses for technicians will be of a much more specialized character than Higher National Certificate courses "The courses should be so designed that they can be followed without the assistance of collateral studies, and examinations should be available to which appropriate awards will be given by an examining body such as the City and Guilds of London Institute The courses should rely as little as possible upon mathematical knowledge, but they should include a large proportion of graphical and of practical work "

The report then deals with practical training "A most important condition of training is that a trainee should follow a carefully planned and supervised course including, especially in the early stages, formal instruction In the subsequent stages, training will of necessity largely take the form of experience to be gained by working in different departments or branches of an organization To help to ensure progressive training, and to attract the right type of recruit, technician apprenticeships extending over a period of four or five years should be offered " Part-time day release, conditional upon satisfactory progress, should be allowed throughout the entire period of apprenticeship It is recommended that all technician apprenticeship schemes, whether in manufacturing or in operating organizations, should provide for an initial period of about eighteen months' duration of training in suitable crafts

The recommendations of the report are in general terms, and no attempt is made to develop detailed schemes for particular branches of the industry The views put forward in the report were, in the main, endorsed in the discussion which followed its presentation, it being generally agreed that the institution of suitable schemes of training for technicians is a matter of first importance in the technical development of the electrical industry

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CHEMICAL RESEARCH LABORATORY

REPORT FOR 1949

THE report of the Chemistry Research Board for the year 1949* which, over the signature of its chairman, Sir Norman Haworth, accompanies the report of the Director of the Chemical Research Laboratory, refers to the careful review of the research programme of the High Polymers and Plastics Section of the Laboratory made by the High Polymers Committee The recommendations of this Committee that the study of the ion-exchange and allied properties of high polymers should continue to be the chief work of the Section, and that research should be begun on the relationships between the properties and chain-length of carefully fractionated linear polymers, with the immediate object of finding improved methods of determining molecular weight distribution, have been endorsed by the Board In consequence, the work on adhesion has been terminated, as the whole of the available staff is required to make an effective contribution to these first two topics During the year under review, the Section examined in detail the reaction of polyvinyl chloride with methylamine and ethylenediamine with the view of elucidating the mechanism of the reaction Exploratory experiments on derivatives of sulphonated cross-linked polystyrene have also been made, and the Director's report includes a brief account of both investigations as well as of those on the preparation and sulphonation of cross-linked polystyrene and the ion-exchange properties of the product In collaboration with the Low Temperature Research Station, Cambridge, it has been shown that the more basic amino-acids—leucine, histidine, lysine and arginine—can be separated by development displacement from a column of sulphonated polystyrene resin of low degree of cross-linking In further work on glues for light alloys, the effect of pre-treatment of metals with different adhesives was compared

An outstanding feature of the Corrosion Group's activities is the increasing amount of time devoted to extra-mural contacts and the handling of technical inquiries, and the Board's report directs special attention to the development of an inhibitor of corrosion consisting of sodium benzoate with a small proportion of sodium nitrite This has been used effectively in glycol anti-freeze mixtures in the cooling systems of motor-vehicles with cast iron cylinder heads and blocks with the usual assembly of other metals. The mixed inhibitor can also be incorporated in rubber latex, which can then be used to form a protective film on machined parts. A study of boiler-tube corrosion was initiated during the year on behalf of the British Shipbuilding Research Association. Besides work on corrosion-testing technique, the Corrosion Group has continued its study of the low-temperature oxidation of mild steel, and an electron diffraction camera has been installed which should considerably assist the study of surface films on metals. Sets of the apparatus developed in the Laboratory for the speedier testing of protective coatings on surfaces against the effect of atmospheric corrosion have been made by the British Iron and Steel Research Association and distributed to other laboratories for trial.

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* Department of Scientific and Industrial Research Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1949 Pp vi+96 (London H M Stationery Office, 1950) 3*s* net

The functions of the Microbiology Section have been extended to include the maintenance of cultures of industrially important bacteria, with ultimate responsibility for the maintenance of a National Collection of such bacteria. Bacteria previously held at the National Collection of Type Cultures have been taken over; but it was anticipated that it would take until the end of 1950 to examine and catalogue them. The fundamental investigations on the biochemistry of sulphate-reducing bacteria have been intensified, and the competitive inhibition of this reduction by selenate is being applied experimentally by incorporating selenate in protective coatings for ferrous pipes buried in sulphate-bearing clay soils. Biological methods for the control of the nuisance of evil-smelling pools produced by the activities of these bacteria are also being investigated.

Work for the Division of Atomic Energy, Ministry of Supply, on the analysis and concentration of uranium in minerals and ores has continued on an increasing scale, including the development and application of methods, based on solvent extraction in conjunction with the use of cellulose and other solid adsorbents, for preparing and analysing inorganic substances, including uranium products. Other work of the Radiochemical Group on the precipitation of uranium and other metals from solution under controlled conditions has also proved valuable in the development of enrichment processes for uranium from low-grade ores. Besides chemical methods of analysis, this Group has made numerous studies in radioactive methods of analysis, and reports substantial progress in polarographic methods for the direct determination of uranium in solutions containing other metals.

The Inorganic Group, which is now equipped with a Jarrell–Ash grating spectrograph, has successfully completed a semi-scale trial of its method for extracting germanium and gallium from flue dust by fusion with caustic soda and obtained an 80 per cent overall yield. A new investigation on the conversion of phosphate rock into forms of fertilizer which are easily assimilated by plants and in which less sulphuric acid is required has yielded promising results in preliminary work with mixtures of nitric and sulphuric acid. In chromatography, a method has been developed for the quantitative separation of nickel, manganese, cobalt, copper and iron in solution as chlorides on paper strips, and the method for nickel, cobalt, copper and iron has been extended to separations on cellulose columns. Much of the work of the Spectroscopic Laboratory has been concerned with the quantitative examination of products derived from eluates obtained in this work with cellulose columns.

A prominent part of the work of the Organic Group is now the determination of accurate physical and physico-chemical data for pure organic compounds, and besides informal discussions between the Director of the Chemical Research Laboratory and Prof. D. M. Newitt, the Superintendent of the Physics Division of the National Physical Laboratory, to co-ordinate work in this field, there has been co-operation with the Hydrocarbon Research Group of the Institute of Petroleum. In consequence, the Laboratory has undertaken responsibility for procuring and distributing a range of standard pure hydrocarbons required for calibrating mass-spectrometers and other purposes. The Purification and Measurements Section has developed methods for the purification of β- and γ-picoline and 2 : 6-lutidine and also new thermodynamic tests for vapour–liquid equilibrium data in ternary systems. An apparatus has been designed for the automatic recording of freezing-point curves, and a method worked out for the determination of 4-methyl-2 : 6-di-tertiary-butylphenol in industrial mixture by infra-red absorption spectroscopy, as well as for the determination of small quantities of water in pyridine homologues. In the Organic Intermediates Section, progress is reported in identifying and synthesizing insecticidal compounds contained in the piperidine- and other nitrogen-containing fractions. Two homologous series of *N*-substituted piperidines are being synthesized for evaluation, and further work has been done on the hydrogenation of diphenylene oxide and *o*-diphenol, as well as on the polymers and co-polymers of acenaphthylene. A considerable amount of effort has been given to the synthesis of carbon-13 labelled intermediates from enriched potassium cyanide, and progress is reported in the elaboration of adequate methods for intermediates. A number of polyfunctional halides and bases have been prepared for the synthesis of ion-exchange resins, and to obtain a non-polar lubrication standard the hydrocarbon, docosane, was synthesized from lauric acid.

GOVERNMENT EXPENDITURE IN THE WELFARE STATE

RECENT reports from the Committee on Public Accounts have indicated that the mounting scale of expenditure on the universities and similar institutions and on the Department of Scientific and Industrial Research is leading to requests for closer public accountability of such expenditure, even by those who are most concerned to safeguard the independence of the universities and who are alive to the danger of cramping research activities by petty restrictions. Possibly the spirit of such requests may be satisfied by a greater disposition on the part of these organizations to recognize that full publication of results as early as possible is a return which the nation is entitled to expect, as indeed was pointed out by one speaker at the British Association meeting in Birmingham; but it is clear from two recent broadsheets issued by Political and Economic Planning that there is a real danger, and that some new means of accountability may have to be devised to satisfy the nation that there is no excessive waste and that a reasonable return is being secured.

The first of these broadsheets, No 317, dealing with government spending, makes it clear that pressure to this end is likely to arise out of the acute problem of adapting the British economy to a big increase in defence expenditure The broadsheet, it is true, is concerned chiefly with examining the nature of government spending and its effects with the view of determining whether it is true that no reduction in government expenditure can be made without doing more harm than good, or whether, on the contrary, a high rate of government spending is a drag on economic progress and a hindrance to the long-term solution of the foreign trade problem

The survey indicates some of the consequences of the Government's need for balancing the claims of defence against those of other economic activities and to decide such questions as the rate of house-building or the amount to be spent on hospitals The Government, it is pointed out, has only a limited control over some parts of the economy It must accept that increased spending by public authorities will probably be at the expense of the provision of industrial equipment rather than of consumption The welfare State involves a high level of taxation to cover large spending by public authorities and large monetary transfers This tends to diminish the traditional incentive to effort and, in the absence of new ones, to check production. This danger may impose limits on what the Government can do with safety

The most important conclusion reached here by Political and Economic Planning is that, while the dependence of decisions on policy to some extent on personal judgment is admitted, with consequent room for dispute, the area of dispute could be reduced if more facts and figures were available Planning decisions must be based on a knowledge of the relevant facts, so far as they can be ascertained It is true that the total effects of a tax, or of taxation as a whole, cannot be assessed with any degree of accuracy , but at present the planning authorities lack knowledge of ascertainable facts The figures on government spending are not available in the most illuminating form

A new classification of government spending may be desirable, and P E P argues convincingly that a more illuminating presentation of the facts about government spending would confer economic benefits by leading to a better organization of the economy Since the official statisticians of the Treasury and the Cabinet Office do not appear to have supplied the Government with all the ascertainable facts about the activity which is most directly under its control, the broadsheet suggests that the official statisticians should share the work with such bodies as the Oxford University Institute of Statistics and the Department of Applied Economics at Cambridge The lead must come from the Civil Service, since the first step is the remodelling of the system of accounting and recording in the various departments If the raw material were thus improved, there is little doubt that the Treasury and the Cabinet Office would receive plenty of outside help in the new research which would be made possible

The second of these broadsheets, No 318, dealing with government and industry, goes further into the doctrine of public accountability, but mainly from the point of view of the relationship of the Government to industry in the so-called 'mixed economy' which Britain has now come to be It attempts to trace the shape of that relationship as it was developing from the full control of the War and its immediate aftermath to a more liberal system The broadsheet assumes that the place of the Government in that relationship will continue to be larger than in days gone by, whatever political party holds the power Some of the fundamental questions which have to be faced in the relations of Government to industry are well summarized in the second broadsheet The first is the fundamental political dilemma of peace-time Is Government intervention in industry on the present scale necessary ? Further, if there is a need, is the present mixed system—'voluntarism', with a background of control—the right one in principle ? Does the system as it operates to-day create the best possible psychological atmosphere ? What is its effect on costs, to the firm and to the community ? Lastly, in the system as it has developed, is the consumer adequately protected ?

SCIENTIFIC COUNCIL FOR AFRICA

EARLY in 1951 the Scientific Council for Africa South of the Sahara held its first session in Nairobi under the chairmanship of Dr P J du Toit of South Africa, and was attended by Prof J Millot (Madagascar), Dr F J Cambournac (Portugal), Sir Alexander Carr-Saunders (United Kingdom), Dr B A Keen (British East Africa), Dr A Mendes Correa (Portugal), Prof T Monod (French West Africa), Col H W Mulligan (Nigeria), Dr B F. J Schonland (South Africa), Mr N P Sellick (Southern Rhodesia), Dr Georges J Bone (Belgian Congo) and Prof Trochain (French Equatorial Africa)*

Being the inaugural meeting, the Council was chiefly concerned with problems of organization and method It proved possible, however, to devote considerable attention to examination of the fifty-three resolutions on scientific collaboration in Africa adopted at the African Regional Scientific Conference in Johannesburg in 1950 These resolutions were thoroughly sifted, and priorities were allocated to assist the Council and governmental and other authorities concerned in carrying out these recommendations Among the proposals which the Council decided should be examined in detail as a first priority were the following the establishment of an Inter-African Regional Bureau on Geology , the achievement of cartographic uniformity in the maps of Africa, and the preparation of special regional maps dealing with such subjects as geology, climatology, vegetation, vector-borne diseases, etc , the extension of co-ordinated development in the field of hydrology and water conservation , the calling of a specialist meeting on housing and building research , and the co-ordination of scientific library and bibliography services

It was reported that considerable progress had already been made in carrying out a number of the Johannesburg Conference proposals Arrangements were made for the appointment of honorary regional consultants and correspondents in Africa representing all the main scientific disciplines

To avoid duplication and overlapping of functions with those undertaken by other organizations, careful attention was given to the recommendations of the several African scientific conferences which have been held in the past few years on such specialized subjects as trypanosomiasis, rinderpest and soil conservation

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* *South African J Sci* , 6, January 1951.

Arrangements were made for submission to the authorities concerned of suggestions about items to be discussed at the African scientific and technical conferences already planned for the next two or three years, the Council endorsed the view that international technical conferences should not continue to be convened on the scale of the past three or four years Major technical conferences in a particular field were regarded as fulfilling most valuable functions if held at intervals of five or more years, but during such intervals the necessary consultation and continuity could best be achieved by arranging meetings of small groups of specialists

In order effectively to initiate the work of the Council, it was decided that the Council's secretariat should be as mobile as possible during the first year of its operation and that, during this period, it should visit the major centres in Africa, spending one or two months at each centre The secretariat is expected to begin full-time work as from about the middle of this year and will be under the direction of Dr E B Worthington, at present scientific secretary of the East African High Commission

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SEISMOLOGY IN GREAT BRITAIN, 1949-50

THE fifty-fifth annual report of the Seismological Investigations Committee of the British Association for the Advancement of Science has recently been published[1] Continuing the work of Davison, Dr A T J Dollar has collected together macroseismic and other information into a paper entitled "Catalogue of Scottish Earthquakes, 1916–49"[2] During this period there was evidence of 120 tectonic earthquakes, including nine principal earthquakes with associated accessory shocks, and five others of secondary or sympathetic origin, but no unequivocal evidence for twin earthquakes The positions of epicentres indicate nine seismic regions, mainly grouped around the margins of the Grampian Highlands Of these regions, Glen More, Breadalbane, Ochil Hills and south Argyllshire showed seismic activities noticeably greater than those in the four regions of Clydesdale, Pentland Hills, Lowther Hills and the Shetland Islands Among seismic centres, Comrie remained outstanding with fifteen earthquakes for the period, followed by Stirling with eleven earthquakes, and Menstrie, Lochgilphead and Lochaber each with six earthquakes Damage produced by these earthquakes was slight and almost entirely structural, generally involving no more than the dislodgment of tiles, slates or chimney-pots In one case, the overthrow of a gable-end near Carron Bridge may have been occasioned by earth tremors in Stirling on July 16, 1940 No human injuries appear to have been caused, either directly or indirectly, by any of these disturbances

The International Seismological Summary continues to be computed by J S Hughes and his staff, working at Kew Observatory by courtesy of the director of the Meteorological Office On November 5, 1938, a very large, shallow-focus earthquake occurred near Hukusima, which was recorded at nearly every seismological observatory in the world and was followed by many after-shocks from nearly the same epicentre This involved an unprecedented quantity of observational material which it was necessary to work up, and has caused some delay in publication At the time of writing, calculations on data from April 1940 are in progress and completed calculations for the last quarter of 1939 are in the Press During 1950 the gap between the dates of the earthquakes and the distribution of the International Seismological Summary concerning them has been noticeably diminished

It is pleasing to note the increased interest in experimental seismology in British universities and research establishments, in addition to the routine investigations made by oil companies The results of Admiralty research on microseisms have appeared in two papers The first, entitled "A Theory of the Origin of Microseisms", is by M S Longuet-Higgins[3] It is suggested that microseisms originate from standing waves on the surface of the ocean The general conditions for fluctuations in the mean pressure over a wide area of the sea surface is that the frequency spectrum should contain groups of waves of the same wave-length travelling in opposite directions The pressure fluctuations are then of twice the frequency of the corresponding waves and are proportional to the product of the wave amplitudes Waves of compression in the ocean- and sea-bed should be set up, which may be of sufficient amplitude to be recorded as microseisms For certain depths of the ocean the displacements will be increased by a factor of the order of 5 owing to resonance Suitable conditions of wave interference over deep water would be probably greater than the effect of coastal wave reflexion The second paper, by J Darbyshire, is on the "Identification of Microseismic Activity with Sea Waves"[4] In this paper three series of simultaneous wave and microseism records are examined They give a clear indication that bands of microseismic waves from different sources can be distinguished by submitting seismograph records to frequency analysis The agreement between the results of analysis and the theoretical expectation from the prevailing meteorological conditions appears to justify the assumption that microseismic waves of different periods travel independently Under the simple meteorological conditions that have been studied, each band of microseismic activity can be identified with a band of sea waves of twice its period

At the Imperial College of Science and Technology London, the elastic properties of rocks at frequencies between 40 and 120 c /s have been investigated, and also experiments have been made on the propagation of elastic waves, of frequency 500–1,000 c /s At the Department of Mining, University of Leeds, field experiments using a Leet three-component seismograph have been made on ground amplitudes and frequencies resulting from blasting operations At the Department of Geodesy and Geophysics, University of Cambridge, experiments have been made on refraction shooting at sea[5] Dr P L Willmore has also further developed his seismograph and it is about to be produced by Messrs Hilger and Watts, Ltd, who also produce the new Milne–Shaw instruments

As already mentioned[6], Dr R Stoneley has discussed the effect of a low-velocity layer below the surface layers of continents, on the amplitudes of surface waves[7]

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LETTERS TO THE EDITORS

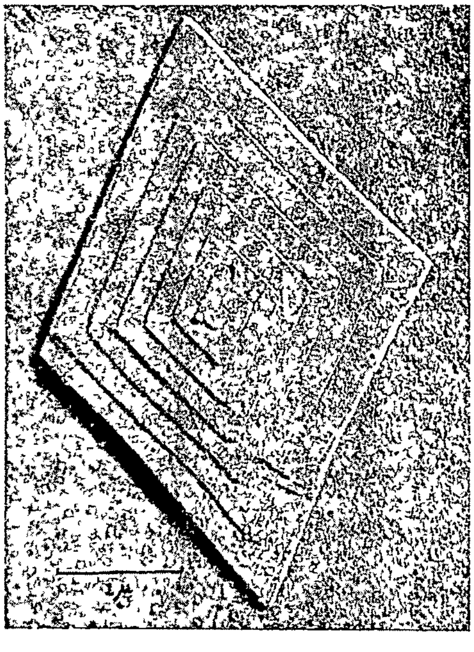
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Observation of Spiral Growth-Steps in *n*-Paraffin Single Crystals in the Electron Microscope

THE effect of dislocations on the growth of crystals was discussed in an article by N. F. Mott[1] published in *Nature* of February 25, 1950. Optical evidence which had been obtained by an interference method by Griffin[2] was cited in favour of spiral growth-steps ending on screw dislocations occurring in beryl crystals, thus supporting the growth mechanism which had been suggested by Frank[3] to account for crystal growth at very low supersaturation values.

Examination in the electron microscope of single crystals of the *n*-paraffin, *n*-hexatriacontane, $C_{36}H_{74}$, has given striking evidence that these crystals do grow out from a dislocation in the primary nucleus.

Small crystals of *n*-hexatriacontane, grown from a solution in petroleum ether, were shadow-cast with palladium[4] and examined in a Philips's electron microscope. The accompanying micrograph shows the simplest type of crystal observed. This, and all the other crystals examined, showed the presence of molecular steps of the type first observed by Robert and Buzon[5] in preparations of commercial paraffin. Closer examination of our micrograph shows, however, that the molecular step edge on the crystal face runs in a continuous spiral from the apex, that is, 'the growth-point', of the crystal to the base, and that the crystals are, in fact, as Frank has suggested, growing, "up a spiral staircase", and not in a series of closed terraces. This, of course, implies that during growth fresh molecules can always condense on a monomolecular edge, and that successive molecular edges do not have to be initiated on the growing crystal face. Under these conditions, growth takes place at a low degree of supersaturation in accordance with the experimental evidence of Volmer and Schultze[6].



The micrograph shown here is an example of the simplest type of spiral dislocation seen in our experiments. Other micrographs show the effects of multiple dislocations on crystal-growth, and these, together with the detailed conclusions which can be drawn from our observations, will be published elsewhere.

We wish to thank Prof. J. M. Robertson for his interest in these results. We are indebted to the Rockefeller Foundation for a grant for equipment, and to Imperial Chemical Industries, Ltd., for research fellowships. The specimen of *n*-hexatriacontane was kindly supplied by Mr. C. W. Bunn.

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Occurrence of Stripped Nuclei of Neon in Primary Cosmic Rays

Bradt and Peters[1], in their analysis of the primary cosmic radiation as observed in the out-of-the-atmosphere observations with the plate technique, have given the completely stripped nucleus of neon as one of the main components of the heavier cosmic particles. In fact, the relative abundance is given as almost the same as that of oxygen-16 (*vide* Fig. 13, p. 66, of their paper).

It appears that if the identification of the stripped nucleus of neon as one of the main constituents of primary cosmic particles be correct, and is confirmed by subsequent observations, it constitutes a very strong argument against the hypothesis that the sun is the source of cosmic particles received on the earth[2,3]. For to have stripped nuclei of neon from the sun, it must be first demonstrated that neon exists on the sun and is at least once ionized on the photosphere or the chromosphere. The evidence on these points, as will be shown presently, is absolutely negative, in spite of the fact that strong lines of Ne and Ne$^+$ occur within the solar range of wavelengths (3,000–10,000 A.).

It is true that the fundamental lines of Ne and Ne$^+$ occur in the far ultra-violet, and the lines which occur in the solar range belong to the transitions

$$\left.\begin{array}{r} 1s^2\,2s^2\,(2p^6\,3s-2p^6\,3p) \text{ or higher transitions} \\ \text{for Ne} \\ 1s^2\,2s^2\,(2p^4\,3s-2p^4\,3p) \text{ or higher transitions} \\ \text{for Ne}^+ \end{array}\right\} \quad (A)$$

But the physical conditions on the sun, as we know, are such that if neon existed there at even moderate strengths the lines of Ne, Ne$^+$ belonging to the above-mentioned combinations could not escape detection, at least in the flash spectrum of the sun. An analogous case is afforded by He and He$^+$, which have their fundamental lines in the extreme ultra-violet, but of the higher transition lines, only λ 10,830.38, $1s\,2p\,^3S_1 - 1s\,2p\,^3P_1$ is found as an absorption line in the Fraunhofer infra-red spectrum[4], and none of the other lines of He, $1s\,(2s\,^{1,3}S - np\,^{1,3}P)$, $1s\,(2p\,^{1,3}P - nd)$, is found ordinarily in the Fraunhofer spectrum, except when the solar atmosphere is disturbed. But the lines $1s\,2p\,^{1,3}P - 1s\,nd\,^{1,3}D$, which include the well-known D_3 and other higher transition lines of helium, are found in great strength in the solar chromosphere, thus proving that though helium exists in great strength in the higher solar atmosphere, it is difficult of observation in the Fraunhofer spectrum owing to the large excitation potential of its excited levels, which can give rise to Fraunhofer lines by absorption But determinations of the abundance of helium to hydrogen in the chromosphere can be obtained on certain plausible assumptions, and are variously given as 1 14, 1 33, etc

The presence of ionized helium in the flash spectrum is indicated through the line λ 4,685 91, $\nu = 4N\left(\frac{1}{3^2}-\frac{1}{4^2}\right)$ This is unexpected, on account of the high ionization potential of helium (24 465 volts), and the extra excitation required to raise normal He^+ to the 4-quantum levels The physical mechanism producing He^+ in the chromosphere is still unknown, and the reader may be referred to a suggestion which I myself have made[5]

If neon were present at some strength in the sun, we could expect, from analogy with helium, that lines of both Ne and Ne^+ would be present in the flash spectrum of the sun But, in spite of laborious attempts, not a single coincidence of the numerous lines of Ne and Ne^+ belonging to combinations (A) could be found in the table of the flash-spectrum of the sun published by Menzel[6] (1931) or Mitchell[7] (1947) We must, therefore, conclude that both Ne and Ne^+ are definitely absent from the atmosphere of the sun

So far as I know, no lines of neon or of any inert gas except helium have been found in the spectra of stars belonging to the main sequence Forbidden lines of Ne^{2+}, Ne^{3+}, Ne^{4+} are found in the spectra of the nebulosity which is formed from gases ejected by a nova, and lines (A) of Ne and Ne^+ have been found in certain B- and A-stars, which show abnormal characteristics like τ-Scorpii These form less than 10^{-4} times the number of stars the spectra of which have been examined, and we are therefore driven to the conclusion that occurrence of Ne and Ne^+ in these rare bodies is due to some extraordinary cosmogenic process The attempt of Harrison[8] to prove the existence of neon in the interior of the sun from opacity data is inconclusive, as his arguments can equally well apply to neighbouring elements like fluorine or sodium

There is therefore at present no positive evidence of the presence of Ne or Ne^+ in the sun or the usual run of stars, and this is a strong point against the hypothesis of the solar origin of our local primary cosmic ray particles The theories which ascribe a high cosmic abundance to neon are not borne out by stellar data

I wish to express my indebtedness to Dr B Peters for discussion of these points during the conference on elementary particles held at Bombay in December 1950, under the auspices of the Tata Institute of Fundamental Research

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Ultrasonic Absorption in Normal- and Para-Hydrogen

SEVERAL years ago it was found by one of us, together with P Mariens[1] and L Thys[2], that the experimental values found for the ultrasonic absorption coefficient is much larger than the theoretical value computed by means of the equation of Kirchhoff–Stokes (viscosity and heat conductivity) This deviation was explained as due to the lag in the establishment of equilibrium between the rotational and the translational energy Since these measurements were made, new and more accurate measurements have been carried out by one of us together with R Vermaelen[3], and also on heavy hydrogen All those determinations were made by means of an acoustical interferometer, in which different quartz crystals and different resonator tubes were used Later, the existence of this relaxation for the rotational energy was proved by dispersion measurements, respectively by E S Stewart, J L Stewart and J C Hubbard[4] On the other hand, the absorption coefficients found by the use of the acoustical interferometer have been criticized by P E Krasnooshkin[5] and more recently by J F W Bell[6] Their argument is that an excess of absorption should be caused by the non-uniform vibration of the crystal surface, which produces excitation of the transverse modes of resonance in the interferometer tube This excess of absorption can be determined by plotting the observed absorption coefficient α_{obs} as a function of the pressure p, whereby

$$\alpha_{obs} = \frac{\alpha_0 \ p_0}{p} + \alpha_1$$

(α_0 is absorption coefficient corresponding to atmospheric pressure p_0, and α_1 is the parasite absorption coefficient) In order to check this theory, we have carried out a series of very accurate measurements

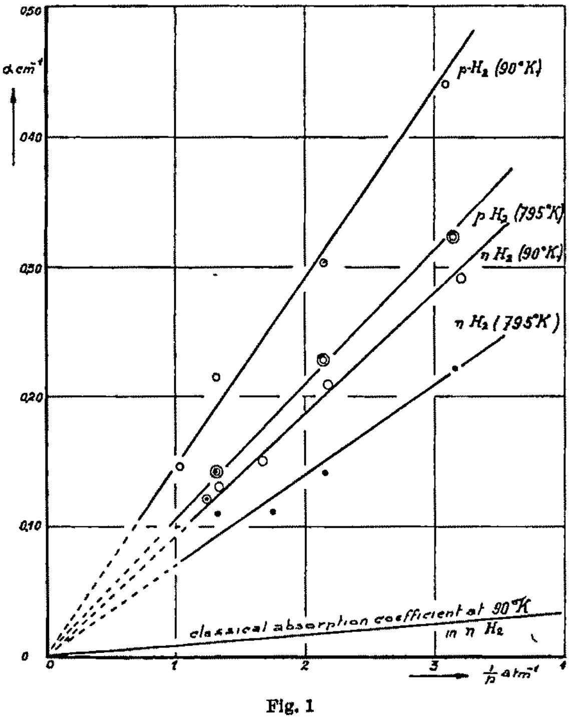

Fig. 1

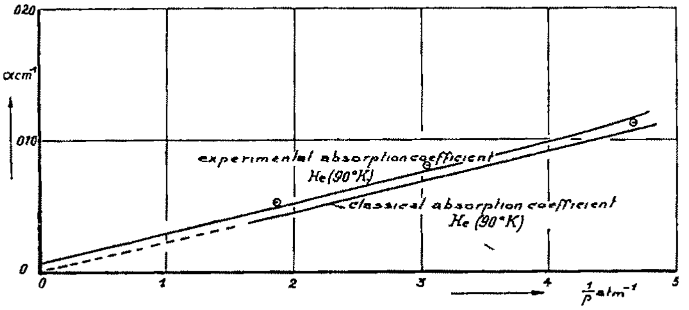

Fig 2

(frequency = 500 0 kc/s) as a function of pressure and temperature (liquid oxygen temperatures) in normal- and para-hydrogen and helium gas

A comparison between the absorption coefficient for the two modifications of hydrogen at liquid-oxygen temperatures, where the velocity is approximately the same, can be considered as a direct control of the influence of the rotational energy on the absorption coefficient.

A plot of our measurements for the case of normal- and para-hydrogen is given in Fig 1, whereby α_{obs} is plotted against $1/p$ From this graph, α_1 is practically zero The classical absorption coefficient has also been plotted on this graph

In Fig 2 are shown the experimental results (full line) for helium gas at the boiling point of liquid oxygen The theoretical absorption coefficient (broken line), computed from the experimental data for the heat conductivity, the viscosity coefficient and the specific heat published in "Helium" by W H Keesom (Elsevier, Amsterdam, 1942) is also shown The agreement of the two curves is quite good, notwithstanding that the measurements are very difficult because of the small value of the absorption coefficient of helium

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Life-time of Potassium Ions on a Tungsten Filament at 1,460° K.

Experiments are proceeding at the University of Birmingham using high-speed rotors as sources of molecular beams[1] Using this technique, it was possible to produce a pulsed beam of potassium atoms, which was employed to measure the life-time of potassium ions on a hot tungsten filament

The rotor consisted of a steel rod, tapered at both ends, spinning about its short axis Each arm of the rotor terminated in a small cup, which was filled with potassium The rotor was accelerated to 1,500 c p s *in vacuo* by means of a rotating magnetic field The heating of the rotor by eddy-current losses resulted in the evaporation of the potassium Pulses of potassium atoms were received by a tungsten filament placed in a tube situated at a tangent to the path swept by the rotor tips

Potassium evaporates from a hot tungsten surface as positive potassium ions This results from the fact that the electron work function of a tungsten surface is greater than the ionization potential of potassium Thus pulses of potassium atoms incident on the hot tungsten filament resulted in pulses of potassium ions being received at a cathode partially surrounding the filament These pulses were recorded by means of an amplifier and a cathode ray oscillograph

The principal time constants which affected the observed pulses were thermal and electrical The thermal time constant resulted from the fact that the potassium ions did not leave the filament instantaneously, but with a speed proportional to the concentration of potassium ions on the filament The electrical time constant resulted from the resistance and capacity at the amplifier input

Pulses were obtained with a thermal time constant corresponding to a filament temperature T and a negligible electrical time constant Pulses of identical size and shape were obtained with a negligible thermal time constant (filament temperature 1,900° K) by increasing the electrical time constant to a value CR by means of a variable capacity Under these conditions, it is easy to show that the thermal time constant at temperature T is equal to CR By this method the time constant for the emission of positive ions from a tungsten surface at a temperature of 1,460° K was found to be 3×10^{-5} sec

The temperature of the filament was deduced from its mass, length and heating current, using Jones and Langmuir's tables[2] The potential across the filament was also measured, and provided an independent determination of the temperature

The evaporation of potassium ions from a hot tungsten surface has been studied by Moon and Oliphant[3] and by Evans[4] These investigations were conducted at surface temperatures of about 1,000° K and showed that the decay of a deposit of potassium upon a hot tungsten surface was exponential Their results demonstrated that the reciprocal of the time constant was proportional to exp $(-\varphi/KT)$, where K is Boltzmann's constant, T is the absolute temperature, and φ is the work function of the surface for potassium ions

The measurement described in this communication agrees with an extrapolation of Evans's results, from which he deduced a value of φ equal to $2\ 4_3$ eV The concentrations of potassium upon the tungsten surfaces were well below monomolecular in both Evans's and our own experiments

We are grateful to Prof P B Moon for suggesting this application of our technique

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Examination of Metals by Polarized Light

Recently, several papers have been published on the use of polarized light for revealing the grain structure of metals and alloys Hone and Pearson[1] showed that by examining under polarized light a polished aluminium surface which had been anodized in a suitable electrolyte, the grain structure was revealed, differently oriented grains appearing with different brightnesses Woodward[2], by etching 'Monel' metal in a specific reagent, has found similar effects Polished surfaces of aluminium and 'Monel' metal, being optically isotropic, do not react to polarized light as do the optically anisotropic surfaces of tin, zinc, cadmium, etc , and the above authors[1,2] have attributed the optical anisotropy of the anodized aluminium and etched 'Monel' metal to the anisotropic properties of the surface film formed during anodizing or etching Although this explanation may be correct, there is a possible alternative which involves the surface contour of the specimen, for it is well known that if pearlite is examined under polarized light no reaction occurs unless the specimen is etched This has been shown convincingly by Baeyertz[3] to be due to the presence of fine parallel grooves on the surface, formed by etching away the ferrite and leaving the cementite lamellæ in relief. Furthermore, Jones[4] has shown that polarization effects can be produced by deeply etching a metal surface

To decide which of these two explanations is correct, electrolytically polished zinc and cadmium, aluminium electrolytically polished and anodized in a solution containing 49 per cent water, 49 per cent ethyl alcohol and 2 per cent hydrofluoric acid at 30 volts, and 'Monel' metal etched according to Woodward[2], were examined before and after evaporating a silver film, approximately 800 A thick, on to the prepared surfaces If the polarization effects are due to optical anisotropy, the silver, being optically isotropic, should destroy them, whereas, if they are due to the surface contour, they should still remain after silvering, for it is known that evaporated silver takes up the surface contour of the surface on which it is deposited (that is, any grooves present before silvering will also be present after)

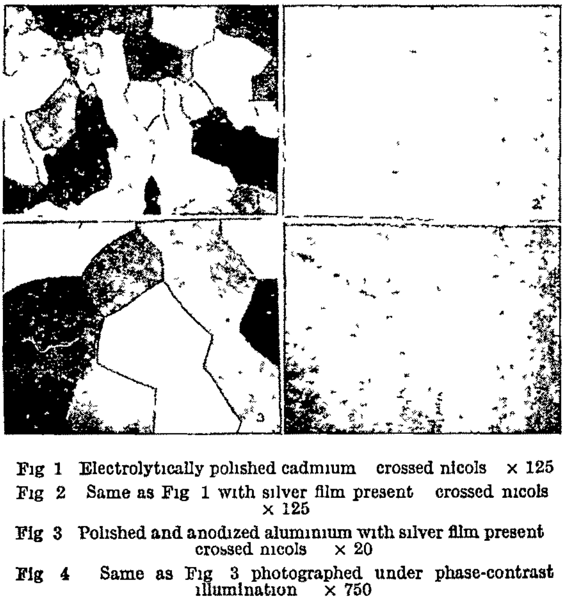

Fig 1 Electrolytically polished cadmium crossed nicols × 125

Fig 2 Same as Fig 1 with silver film present crossed nicols × 125

Fig 3 Polished and anodized aluminium with silver film present crossed nicols × 20

Fig 4 Same as Fig 3 photographed under phase-contrast illumination × 750

Without the silver film, all four surfaces reacted to polarized light, a typical example being shown in Fig 1 After silvering, the zinc and cadmium showed no polarization effects (see Fig 2), whereas both the etched 'Monel' metal and anodized aluminium still reacted to polarized light after deposition of the silver film (see Fig 3) Similar results were also obtained on aluminium which was electrolytically polished and anodized in the way described by Hone and Pearson[1] It is clear, therefore, that the polarization effects obtained with anodized aluminium and etched 'Monel' metal are due to some surface structure and not to true optical anisotropy The silvered aluminium and 'Monel' metal surfaces were examined under the phase-contrast microscope, which is very sensitive in revealing small differences of level, to discover if some such structure could be seen A structure was clearly seen on the aluminium (see Fig 4), and faint evidence of one on the 'Monel' metal Electron microscopic examination of the 'Monel' confirmed that a very fine structure was present That the structure shown in Fig 4 is due to the anodized aluminium surface and not to the silver alone is shown by the fact that a silver film evaporated on to an electrolytically polished aluminium surface showed no markings when examined under the phase-contrast microscope

Further support for these conclusions was found in the observation that if polished aluminium is anodized in a solution containing 12 per cent disodium acid phosphate and 0 4 per cent sulphuric acid in water, which according to Edwards and Keller[5] gives a structureless oxide coating as seen by the electron microscope, no polarization effects are observed

We thank the Director and Council of the British Non-Ferrous Metals Research Association for permission to publish this communication

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Nov 9

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Source of the Light recorded in Photographs of Detonating Explosives

It is now generally recognized that a large part of the light arising from the detonation of a condensed explosive cartridge is due to the system of shock waves produced in the surrounding air[1]. When the air is replaced, for example, by water, the total luminosity is greatly reduced The wave-speed photographs shown in Fig. 1 illustrate this effect

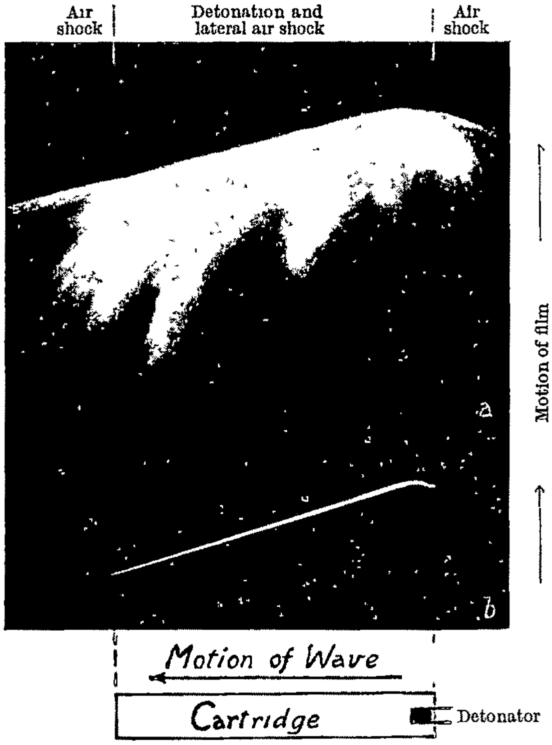

Fig 1 Side-on rotating-mirror photograph of blasting gelatine detonating at high velocity in (a) air, (b) water

The light still reaching the camera when atmospheric shocks are eliminated might be supposed to arise from chemical reaction , and indeed a measurement of the reaction time has been proposed[2] in terms of the breadth of traces such as that shown in Fig 1(b) Even if the light were due to reaction, however, we should have no guarantee that its duration corresponded to the reaction time—it might well be either longer or shorter , and, in fact, it appears unsafe to assume that the light from a granular explosive is necessarily associated with reaction at all A theory of reaction-zone structure in granular explosives, which it is hoped to publish shortly, leads one to expect very high temperatures in the air-pockets between the explosive grains, before reaction commences It is at least possible that the light comes partly (or even entirely) from these

In order to test this suggestion, composite charges were made by loading common salt and a plastic explosive in alternate layers in a celluloid tube The charges were enclosed in wide water-filled glass tubes and fired in a side-on position in front of a high-speed drum camera Fig 2 shows a typical record Contrary to what might at first glance be supposed, the intense streaks of light correspond to the layers of salt and not to those of explosive , this is made clear by reference to the key The layers of explosive give very faint wave-traces on the original negative , these are not detectable on the print There is no light from the water shock

That the light emitted by the salt layers arose within the depth of the salt and not merely on its surface was confirmed by firing two further shots, similar to the above, in one of which the salt was blackened by mixing it with 1 per cent of lamp-black The blackened salt was found to contribute much less light than the translucent material

A final demonstration was provided by firing three cartridges in a head-on position towards the camera (In order to avoid damaging the lens, the cartridges were actually fired downward, and a 45°-mirror used for reflecting the light, but this does not affect the argument) The end of each cartridge remote from the detonator and nearest to the lens was butted tightly against a small block of 'Perspex' Since only this end surface is viewed by the camera, water confinement is then unnecessary, and the sloping lines in Fig 3a, b, c represent lateral air shocks they are cut short by the limited size of the mirror Between these lateral traces is a dark space, where the undetonated layers of explosive obscure the approaching wave This can become visible only when it reaches (or nears) the end of the charge Fig 3a, which corresponds to a cartridge of the plastic explosive alone, shows practically no light from the detonation wave a diffuse flash some 30 microsec later was due to impact on the mirror However, when a half-inch thick layer of common salt is interposed between explosive and 'Perspex' (Fig 3c), a most intense band of light is recorded Fig 3b provides interesting confirmation in this case the explosive was butted directly against the 'Perspex', but a series of parallel scores were first made on its end surface These produce bright flashes of light when the wave reaches them For comparison, Fig 3d is a record of a cartridge of the *granular* explosive *PETN* This produces a band of light comparable with that arising from the salt in Fig 3c

The significance of these photographs is clear No appreciable light is emitted by the detonation reaction in the plastic explosive, the texture of which almost precludes the presence of air pockets , but copious light is emitted by the non-reactive salt, which, of course, contains abundant air pockets When air-spaces are artificially introduced into the plastic explosive, it becomes luminous on detonation. Finally, a granular explosive, less *brisant* than the other, emits intense light

It would be premature, on the basis of these experiments alone, to suggest that none of the light recorded from detonating condensed explosives is due to chemical reaction Instances may be quoted, such as liquid nitroglycerine, where a luminous wave is observed in the (apparent) absence of air-bubbles However, the observations which we have reported make it probable that, after atmospheric shocks have been suppressed, a great part at least of the remaining light from a granular detonating explosive is due to

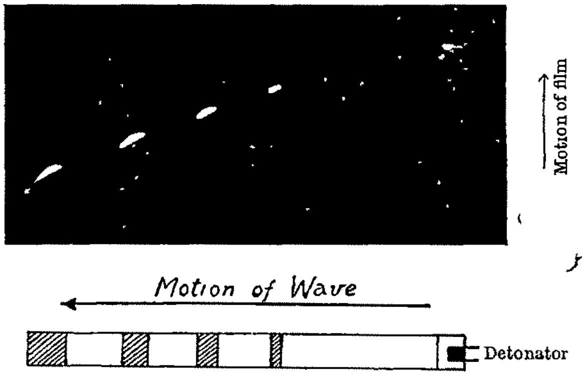

Fig 2 Side-on photograph of composite charge fired under water , shaded portions, sodium chloride , unshaded, plastic explosive

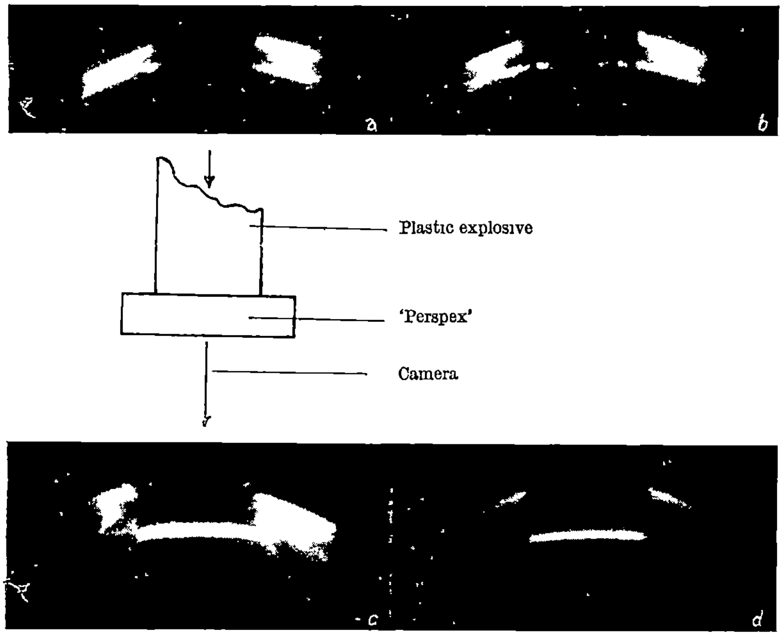

Fig 3 End-on photographs through 'Perspex' blocks (*a*) plastic explosive, end plane, (*b*) plastic explosive, end scratched, (*c*) plastic explosive and common salt, (*d*) *PETN*

compression of the air pockets between the explosive grains This confirms the theory referred to above, and simultaneously casts doubt on any estimate of reaction time in terms of the duration of luminosity

The high-speed photographs were taken by Mr J King, to whom my thanks are due

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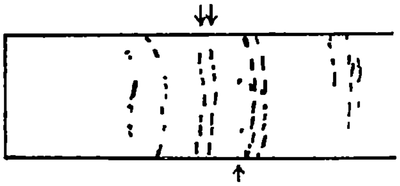
New Approaches to the Interpretation of X-Ray Powder Photographs

The interpretation of powder photographs, despite recent attempts at systematization[1-3], remains still argely an art, and any aids towards simplification are greatly to be welcomed We have discovered that some help can be given by photographs that are usually classed as 'poor', in the sense that the grain size of the specimen is large and the lines are therefore rather 'spotty'

A general advantage of such photographs is that they give some idea of the multiplicity factors[4] of the reflexions, if the number of spots contributing to a particular line is abnormally small, one can be reasonably sure that the multiplicity factor is small, and therefore that the indices are fairly simple—for example, $h00$ This is illustrated by the accompanying diagram, which is a diagrammatic representation of he first few lines of a powder photograph of the alloy CdMg, the line marked with the lower arrow is more sparsely populated than its neighbours and therefore is likely to be of the type $h00$

A point of more limited application also arises from the photograph the two lines marked by the upper arrows have the same general appearance, and we may therefore deduce that they have a common origin, as for certain lines given by the alloy FePt[5] This is possible because at high temperatures the alloy CdMg is hexagonal[6], and the structure we are concerned with is formed by transformation at a lower temperature The two lines are near the position of the line $10\bar{1}0$ given by the close-packed hexagonal structure, and so we may guess that the structure is orthorhombic, the indices of the lines being 110 and 200[7]

If this guess is correct, the values of the reciprocal constants a^* and b^* are directly deducible, and since these do not correspond in any simple way to the value given by the other line considered, we may deduce that this line is 002 The three reciprocal constants thus obtained were adequate to explain all the lines on the X-ray photograph (The actual photograph from which the values of $\sin^2\theta$ were derived was obtained from a specimen having smaller grain size, the lines, although still spotty, were much more nearly uniform than those illustrated in the drawing) While the more systematic methods referred to would no doubt also have led to this result, the methods just described must be many times faster



Diagrammatic representation of part of powder photograph of CdMg

The unit cell has dimensions $a = 5\ 24$ A, $b = 3\ 22$ A, $c = 4\ 97$ A, and, from comparison with the close-packed hexagonal structure it contains two atoms of cadmium and two of magnesium The structure is isomorphous with AuCd[8]

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'Window Fields' in Muscle

The 'membrane', that is, the electric double layer, surrounding the muscle fibre generates no field of forces inside the system. If, however, part of the membrane becomes depolarized, the depolarized part acts, so to say, as a 'window' in the closed system and an electric field is generated. If the depolarization should occur with a sharp border, the maximal intensity of the field in the axis of the fibre would correspond to a field generated between the two plates of a condenser placed at a distance equal to the diameter of the fibre and having the same potential difference as the two sides of the 'membrane'. If the wave of depolarization travels along the membrane, this will have the same effect as if we had pulled electrodes along the axis charged correspondingly. Experiments, performed along this line by St. Hajdu and one of us, show that such a field will actually bring the contractile matter directly to contraction even if the membrane is inoperative.

It is an interesting property of the 'window field' that its time integral is independent of the sharpness of the borderline of the wave of depolarization, and that the time integral of the component of the field parallel to the axis is identical for any point of the cross-section. It is equally noteworthy that the time integral of the component of the field, vertical to the axis is zero. The parallel component will act as a direct current, the vertical one as an alternating current.

There seems to be thus no 'transmission' of excitation from the membrane to the contractile matter; depolarization and the elicitation of contraction merge into one single physical event.

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A New Blood-Group Antigen

A serum that identifies a new blood-group antigen was obtained from the parturient mother of a baby with erythroblastosis fœtalis. Mrs Kidd had had five previous pregnancies but no blood transfusions. No previous babies had erythroblastosis fœtalis. She was delivered on April 17, 1950, of a male infant who developed typical erythroblastosis fœtalis, and whose cells gave a positive direct Coombs's test. On routine testing of Mrs Kidd's serum at that time, it was apparent that it contained a previously unidentified antibody.

Typing tests showed Mrs Kidd to be *O*, *CDe/cDE* (R_1R_2), *MsMs*, *Pp*, $Le(a-b+)$, $Fy(a-)$, *kk*. Her cells were not agglutinated by her own serum. The baby is *O*, *CDe/cDE* (R_1R_2), *MSMs*, *pp*, $Le(a+b+)$, $Fy(a+)$, *Kk*.

The serum was further tested against the bloods of 210 unrelated persons. Of twenty-one *Kell*-positive bloods, all were agglutinated by the Kidd serum. The presence of anti-*Kell* was later proved. Of the remaining 189, all *Kell*-negative, 146 (77 per cent) were agglutinated. Chi square tests failed to show any serological relation of the new antigen to the antigens of the *ABO*, *MNS*, *P*, *Rh*, *Lewis* or *Duffy* blood-group systems, or to sex. Insufficient evidence has been obtained as to the relation, or lack of relation, to the *Lutheran* and *Kell* blood-group systems. Further selective absorption studies and family studies will be required.

The new antibody gave specific reactions at 37° C. against red cells suspended in saline, in a titre of 1 : 16. The reactions were no stronger in bovine albumin, but a titre of 1 : 64 was obtained by Coombs's method. On storage, the saline-active component has disappeared, leaving a component active by the Coombs's method. A saline-active component of the anti-*Kell* made it impossible to distinguish *Kell*-positive, *Kidd*-negative bloods.

On the basis of these preliminary tests, it is possible to say that a new blood group antigen has been identified, present in the red cells of about 77 per cent of Americans. If it is inherited as a dominant, the gene frequency in Americans is approximately 52 per cent. It is proposed to name the new antigen Jk^a (after Mrs Kidd's son); its inheritance is now being investigated.

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Sweating in Man from the Intradermal Injection of *nor*Adrenaline

It has been generally believed that sweating in man is produced in response to sympathetic nervous activity by the liberation at the termination of the post-ganglionic fibre supplying the sweat gland of acetylcholine[1], the transmitter being different from that liberated by sympathetic fibres supplying other organs, which, until recently, was believed to be adrenaline. However, evidence has accumulated that there is an adrenergic component in sweating in man. Sweating is a prominent feature in patients with phæochromocytomata[2], which were believed to secrete adrenaline. Spontaneous sweating in man is abolished by the adrenolytic agent 'Dibenamine'[3]. The intradermal injection of adrenaline has been shown to produce sweating[4].

Recently, evidence has accumulated that the post-ganglionic sympathetic transmitter is probably *nor*adrenaline[5-9]. Also the ergone predominantly present in phæochromocytomata has been shown to be predominantly *nor*adrenaline[2,10].

It was therefore considered of importance to determine whether the local injection of *nor*adrenaline could produce sweating. The method used for detection of sweat-gland activity was that described by Masao Wada[4]. Briefly, the area of skin to be examined is painted with a 3 per cent iodine in absolute alcohol solution and dried completely; the area is painted again with a mixture of 100 gm. fine starch powder and 100 ml. of castor oil. Sweating is evidenced by the appearance of blue dots at the mouths of the sweat glands.

Adrenaline hydrochloride and *nor*adrenaline bitartrate monohydrate were prepared in dilutions of 10^{-3} to 10^{-8}. A small amount of a saline control solution and the different dilutions of the adrenaline and *nor*adrenaline solutions were injected intradermally in the skin areas prepared as described. Sweating was produced with the dilutions 10^{-3} to 10^{-5} with both the adrenaline and *nor*adrenaline solutions in all of five subjects, and in some cases with a dilution of

10^{-6} In one subject the investigation was repeated one hour after the subcutaneous administration of 1/75 grains of atropine sulphate, and no alteration in the response was noted, suggesting that the sweating is due to the direct stimulation of the sweat glands by the injected solutions, and that cholinergic fibres do not play a part in its production

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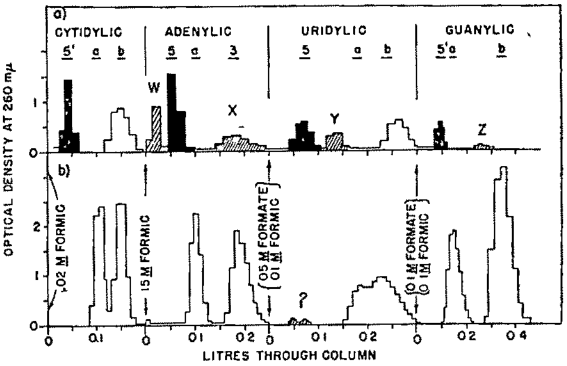
Nucleoside-5′-Phosphates from Ribonucleic Acid

THOUGH the manner in which the four nucleotides of ribonucleic acid are combined in the intact molecule is not completely settled, the data obtained from analyses of the chemical degradation products are most compatible with phosphoryl-group attachments through the C_2 and C_3 positions of the ribose group[1] The exclusion of C_5 phosphoryl linkages rests principally upon the failure to isolate 5′ nucleotides or the acid-stable ribose-5-phosphate from acid hydrolysates of ribonucleic acid However, Gulland and Jackson[2], hydrolysing yeast ribonucleic acid with a snake venom containing a phosphodiesterase and a specific 5′ nucleotidase, found 35 per cent of the total phosphate liberated as inorganic phosphate, suggestng that a large number of the phosphoryl groups were attached to the ribose C_5 position Recently, Schmidt[3], utilizing periodate titrations of ribonuclease-hydrolysed yeast ribonucleic acid, concluded that some nucleotide groups had been linked to positions other than ribose C_2 or C_3 in the original ribonucleic acid The experiments described below ndicate that intact 5′ nucleotides can be isolated from enzymatically hydrolysed calf liver ribonucleic acid

Calf liver ribonucleic acid, prepared by a technique avoiding the use of alkaline solutions[4], was hydrolysed uccessively by crystalline ribonuclease and by alkaline intestinal phosphatase in the presence of odium arsenate to inhibit excessive dephosphorylation of the derived nucleotides, as originally described by Klein[5] for the enzymatic production of deoxyribonucleotides The reaction was allowed to proceed until about 75–80 per cent of the total titratable phosphoryl groups were released, after which the digestion was stopped by the addition of formic acid to a concentration of 0 1 *N* The nucleotide products of the digest were then isolated by the anion-exchange procedure described by Cohn[6]

The accompanying diagram shows the ion-exchange lution curve of the nucleotides isolated from the digest The identification of the 5′ nucleotides indicated on he figure was made chiefly by comparing their properties with those of the corresponding synthetic 5′ nucleotides (we are indebted to Dr D M Brown and Prof A R Todd for generous samples of synthetic guanosine-5′-phosphate, uridine-5′-phosphate and cytidine-5′-phosphate) as follows (*a*) the ion-exchange elution positions are identical with those of the analogous 5′ nucleotides (and deoxynucleotides) and are readily differentiated from the *a* and *b* isomeric forms[6,7] , (*b*) the spectrophotometric absorption characteristics of the isolated pyrimidine-5′-phosphates show definite differences from those of the *a* and *b* forms, but are exactly those of the corresponding synthetic substances , (*c*) the isolated adenosine-5′-phosphate and muscle adenylic acid were both deaminated at exactly the same rate by a preparation of Schmidt's muscle adenylic acid deaminase[8], whereas adenylic acids *a* and *b* were unaffected by the enzyme , (*d*) a highly specific preparation of bull semen 5′ nucleotidase (kindly supplied by Dr L A Heppel) readily and rapidly dephosphorylated all of the isolated 5′ nucleotides, as well as the synthetic 5′ nucleotides, but was completely inactive towards all *a* and *b* mononucleotides , (*e*) the isolated 5′ adenylic acid contained adenine, pentose (orcinol reaction) and phosphate in a 1 1 1 proportion Deoxypentose (diphenylamine reaction) was not present in any of the 5′ compounds nor was acid-labile phosphate (1 *N* hydrochloric acid, 1 hr , 100° C)



Analyses of (*a*) enzymatic digest, (*b*) alkaline digest of 20 mgm of calf-liver ribonucleic acid by ion-exchange Exchanger 'Dowex-1' (formate form), 200–400 mesh, 7 cm × 0 88 sq cm Influent formic acid and sodium formate, as shown , 0 6 ml /min

Enzymatic resynthesis of smaller fragments, rearrangements of mononucleotides to yield the 5′ compounds during the enzymatic hydrolysis and pre-existence of the free 5′ compounds were excluded by the following experiments (1) a similar enzymatic hydrolysis of ribonucleic acid carried out in the presence of isotopic inorganic phosphate yielded 5′ and 3′ nucleotides containing none of the isotope (nor was arsenate incorporated) , (2) incubation of a mixture of the nucleosides or nucleotides with the phosphatase in a phosphate medium resulted in no measurable synthesis of any of the 5′ nucleotides , (3) acid and alkaline hydrolysates yielded neither 5′ nucleotides nor ribose-5-phosphate , (4) ribonuclease alone or ribonuclease followed by alkaline hydrolysis yielded no 5′ nucleotides , these appeared only after phosphatase treatment Thus, if isomerization during digestion does indeed take place, it must occur at the polynucleotide level

It is our intention to use ion-exchange chromatography, already responsible for the isolation of many new nucleotides[6] from nucleic acid hydrolysates, to determine the generality of this finding, as well as in the search for hitherto unknown constituents (for example, *W*, *X*, *Y*, *Z* and ? in the diagram).

This work was performed under Contract Number *W*–7405–Eng –26 for the U S Atomic Energy Commission

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Nature of the Activation Process in Enzymatic Reactions

THE study of enzyme-catalysed reactions has thrown considerable light on the geometrical factors involved, but little is as yet known concerning the mechanism of the activation process The experiments reported here were designed to yield information on the transformations which occur during enzyme action

In the first investigation, carbobenzoxy-L-phenylalanine was incubated with and without chymotrypsin in oxygen-18 water ($H_2{}^{18}O$) In one experiment, crystalline bovine serum albumin was included Following incubation, the reaction mixture was acidified (*p*H 3), the carbobenzoxy derivative was centrifuged, washed with water, and converted to phenylalanine by hydrogenation in aqueous methanol in the presence of palladium black After crystallization from water, the amino-acid was decarboxylated at 270–290° in a mixture of diphenylamine and diphenylmethane[1], and the oxygen-18 concentration of the resulting carbon dioxide determined

Phenylalanine was similarly incubated in oxygen-18 water with and without chymotrypsin , the acidified reaction mixture was taken to dryness, the phenylalanine hydrochloride extracted from the salts with absolute ethanol and the free amino-acid precipitated with pyridine The results are given in the accompanying table

Compound	Oxygen-18 (atom per cent excess)
L-Phenylalanine	0 000
Cbz-L-Phenylalanine	0 009
Cbz-L-Phenylalanine + chymotrypsin	0 470
Cbz-L-Phenylalanine + chymotrypsin	0 524
L-Phenylalanine + chymotrypsin	0 028
*Cbz-L-Phenylalanine + chymotrypsin	0 412
*Cbz-L-Phenylalanine + chymotrypsin + 25 mgm bovine serum albumin	0 392

* 4-hr incubation

100 mgm of Na_2HPO_4 and 41 mgm of KH_2PO_4 were dissolved in 5 c c of $^{18}H_2O$ (1 13 atom per cent excess ^{18}O) and 100 mgm of carbobenzoxy-L-phenylalanine or 65 mgm of L-phenylalanine were dissolved in this buffer (*p*H 7 0) Following the addition (where indicated) of 20 mgm of crystalline chymotrypsin (Armour), the solution was incubated at 37° for 6 hr

It can be seen that, under the influence of chymotrypsin, the carboxyl group of an N-acyl aromatic amino-acid is activated and the oxygen atoms exchange with those of the medium The presence of serum albumin has no marked effect In the absence of enzyme the exchange does not occur The free amino-acid is apparently not activated by chymotrypsin

It is of interest that N-benzoyl D- and L-phenylalanine are inhibitors of chymotrypsin[2] (cf also ref 3)

In another investigation, the nature of the activation process in transamination reactions was studied Konikova, Dobbert and Braunstein[4] had previously indicated, on the basis of densimetric estimation of the amount of deuterium passing into the medium, that the deuterium atom of α-deuterio α-amino-acids undergoes exchange with the hydrogen of the solvent water under the influence of glutamic–alanine transaminase This has now been investigated by direct isolation and analysis When L-leucine, containing 4 5 atomic per cent excess nitrogen-15 and 82 atomic per cent excess deuterium in the α-position, was incubated for 90 min with minced pig heart, it lost more than 98 per cent of the deuterium but none of the nitrogen-15 [5] With D-leucine, neither deuterium nor nitrogen-15 was lost When the L-leucine was incubated with 1 equivalent of α-ketoglutaric acid, more than 98 per cent of its deuterium was lost and the concentration of nitrogen-15 dropped to 3 8 atomic per cent excess[6]

In both cases the interaction of the enzyme and substrate results in an activated structure which can in the first example exchange with the hydroxyl ions, and in the second with the hydrogen ions of the water In neither case is the usual reaction associated with these enzyme systems observed, namely, the hydrolysis of a peptide bond or the conversion of the amino-acid to the corresponding keto-acid Were it not for the changes in the isotopic composition of some of the components of the system, no chemical reaction would have been observed These changes result from the nature of the activated structure, the formation of which precedes and is essential for the complete chemical reaction The ensuing steps, for example, the hydrolysis of the peptide bond, would then be spontaneous For this reason it may be appropriate to call the reactions observed *virtual reactions*

Further work is necessary to elucidate the detailed mechanisms responsible for the observations reported here

This investigation was supported by a grant from the American Cancer Society on the recommendation of the Committee on Growth (National Research Council)

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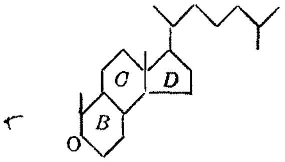
Final Stages of the *A* → *BCD* Route to Cholesterol

THE ketone (I), termed Inhoffen ketone[1], has been obtained from cholestenone by improved methods When pure, it has a melting point of 52° , it was originally described as an oil (semicarbazone, m p 225°, which we confirm) and was crystallized in this laboratory by R P A Sneeden (m p 42°)

The Inhoffen ketone might well have been convertible to cholestenone by direct condensation with diethylaminobutanone methiodide under suitable conditions However, this reaction did not succeed



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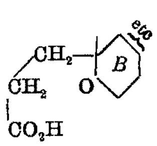

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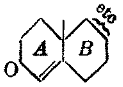

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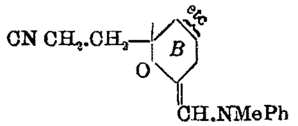

IV

although it gave good results with *cis*-1-methyl-2-decalone[2] The cause is the *trans*- junction of rings *B* and *C*, and a similar difficulty was encountered with *trans*-1-methyl-2-decalone This obstacle was surmounted by protecting the methylene group adjacent to carbonyl, when the sluggish process can be forced by more vigorous conditions Our first objective was, however, the Windaus acid (II), because this has already been converted into cholestenone[3] and hence into cholesterol (Ruzicka, Birch, Dauben)

The hydroxymethylene derivative of the Inhoffen ketone was condensed with methylaniline[4] and the product with acrylonitrile in the presence of 'Triton B' to give IV After hydrolysis with acid and later with alkali, the authentic Windaus acid (II) could be separated and purified The identity with the acid from cholestenone was confirmed by undepressed mixed melting point and by comparison of rotatory power and X-ray diffraction patterns of the crystals Mrs D Crowfoot Hodgkin kindly carried out the latter experiments and reports that the two specimens submitted to her are identical

Thus the Inhoffen ketone is a substance that can be transformed into cholesterol We now intend to dehydrogenate ring *B* of this ketone and to attempt a junction with the *BCD* tricyclic ketones already synthesized in this Laboratory[5]

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Occurrence of Asperuloside in *Daphniphyllum macropodum* (Euphorbiaceæ) and a closely related Glucoside in *Monotropa hypopitys* Walt. (Pyrolaceæ)

As knowledge of the chemical constitution of plant products extends, types of substances, and individual substances, which were formerly thought to be characteristic of certain taxonomic divisions of plants, are found to occur in divisions, which, on other grounds, are considered to be unrelated The glucoside asperuloside, first isolated by Hérissey[1], has hitherto been regarded as a characteristic product of plants of the family Rubiaceæ and has been isolated from many of its species It will be of interest to the student of chemical taxonomy that, in the course of a study of asperuloside, this glucoside has been isolated from *Daphniphyllum macropodum*, which is a Chinese plant of uncertain affinity, placed in the family Euphorbiaceæ, and that a very similar glucoside occurs in the uncommon saprophytic plant *Monotropa hypopitys* Walt, which is placed in the Ericales, family Pyrolaceæ

1 8 gm of asperuloside was isolated from 315 gm fresh leaves of *D macropodum*, kindly supplied by Mr J Gilmour, director of the Royal Horticultural Society's Garden This material has the following constants m p 126°–129° $[\alpha]_D^{18}$ −200°, C, 50 7 per cent, H, 5 6 per cent The constants of an authentic sample of asperuloside prepared from *Rubia tinctorum* were m p 125°–127°, $[\alpha]_D^{18}$ −204°; C, 50 9 per cent; H, 5 7 per cent A mixture of the two preparations melted at 126°–129° The glucoside from *Daphniphyllum* crystallized on seeding with the authentic material, and both substances ran at the same rate in two different solvent mixtures on filter-paper chromatograms

Asperuloside has a number of highly specific colour reactions which make it very easy to detect These are also given by a glucoside prepared from *Monotropa hypopitys*, which is identical with "monotropéine" isolated from this plant by Bridel[2] The following properties described by Bridel distinguish it from asperuloside, it is acid to litmus, whereas asperuloside is neutral, decomposes sodium carbonate and has the following constants m p 175°, $[\alpha]_D$ −130 4°.

I am indebted to Mr E J H Corner, of the Botany School, Cambridge, for suggesting the investigation of *Daphniphyllum macropodum*, and to Dr R Hill for his close interest in this work

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Melting Points of Mixtures of Cetyl Caprate with Lauryl Myristate

THE work of Oldham and Ubbelohde[1] suggested that the melting point of mixtures of dipolar compounds may be much lower than predicted by the Le Chatelier – Schroder (or Hildebrand) equation[2] if one uses components which are able to crystallize in a composite lattice but are sufficiently different in chain-length to lead to the formation of a defective lattice The formation of lattice flaws is made possible

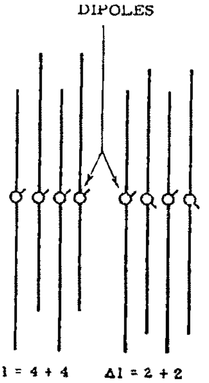

Fig 1 Alternate possible arrangements of lauryl myristate and cetyl caprate in composite crystal lattices
Δl = size of gaps (in number of C-atoms) in the lattice

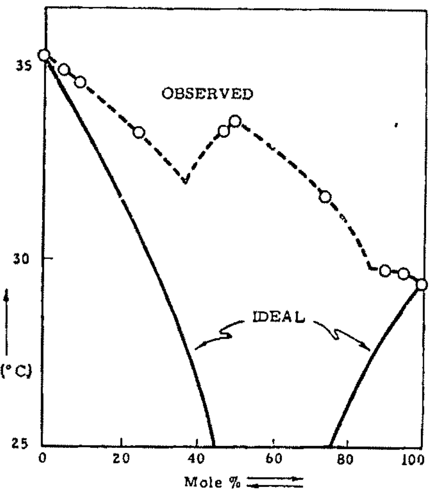

Fig 2 Melting-point curves of mixtures of lauryl myristate (m p 35 3° C) and cetyl caprate (m p 29 4° C)

by the arrangement of the dipoles of all components in continuous dipole sheets throughout the crystal Oldham and Ubbelohde proved the usefulness of this picture for mixtures of various long-chain ketones In order to test the applicability of this hypothesis to mixtures of esters, a series of mixtures was prepared from two esters (cetyl caprate and lauryl myristate) which happened to be available in better than 95 per cent purity The over-all chain-length of these esters is identical, but their arrangement along a dipole sheet would lead to a high concentration of lattice flaws (Fig 1) Judging by Oldham's work, the relative concentration of lattice flaws in either configuration should be sufficient to promise a substantial reduction in lattice stability, that is, in melting point

This expectation was not fulfilled by the experimental data, shown in Fig 2 Rather to the contrary, there are even indications of a maximum in the melting-point curve, in addition to the indications of formation of solid solution The solid-solution-like behaviour suggests that—as has been indicated by dielectric loss measurements[3]—the ester dipole interaction is too weak to lead to the formation of dipole sheets against the forces of the 'horror vacui', while the very much stronger ketone dipole interaction observed by Oldham and Ubbelohde is well able to do so. Instead, the ester mixtures behave more like a mixture of normal long-chain hydrocarbons, and apparently form solid solutions involving continuous (flawless) parallel arrangement of all molecules in the crystal lattice The maximum may simply reflect the formation of a crystal modification ('compromise lattice') unrelated to the crystal structure of either component[4] Proof for this explanation could only be obtained by X-ray diffraction measurements The occurrence of similar solid-solution phenomena in crystallized chain co-polyesters[5] points to the generality of the observations reported

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Frequency Factors in a Series of Similar Unimolecular Reactions

Our present knowledge of the frequency factors of unimolecular reactions is very limited Polanyi and Wigner[1] were the first to elucidate the meaning of this entity and their treatment suggested a magnitude of the order of 10^{13} sec $^{-1}$ for the frequency factors of unimolecular reactions This conclusion was confirmed by many experimental observations and by further theoretical studies[2] We lack, however, more precise information about the dependence of the frequency factors on molecular structure and on the type of reactions

There are several difficulties in assembling the data required for this purpose Many reactions, originally claimed as unimolecular, have been shown by later investigations to be complex processes, often involving a chain Further difficulty arose from the fact that frequently the character of a reaction is changed with temperature For example, a process which for all practical purposes is unimolecular in character at one temperature may be accompanied by a heterogeneous reaction at lower temperature, or by a chain at higher temperature In consequence, the activation energy of such a unimolecular reaction would be estimated in an erroneous way, and since the computation of the frequency factor requires the determination of the activation energy, the error in the latter causes considerable error in the former

The absolute values of the frequency factors of unimolecular reactions reported in the literature are subject to appreciable uncertainty, caused by the difficulties mentioned above, and in our opinion an error by a factor of 2–3 might be quite common It seems, therefore, that the available data are not sufficiently accurate to enable us to draw any conclusions regarding the factors affecting the magnitude of frequency factors However, one regularity may be claimed, namely, the frequency factors seem to remain constant for a series of similar processes For example, it was shown experimentally[3] that the frequency factors remain constant and equal to about 2×10^{13} sec $^{-1}$ for a series of unimolecular dissociation processes of the type

$$RH \rightarrow R + H,$$

R being $C_6H_5\,CH_2$, p-$CH_3\,C_6H_4\,CH_2$,
m-$CH_3\,C_6H_4\,CH_2$, and o-$CH_3\,C_6H_4\,CH_2$

The constancy of frequency factors for such a series may be demonstrated by a more exact method It is extremely improbable that, in a series of similar decompositions, the variation in activation energy would be just balanced by the variation in the frequency factor, thus leaving unchanged the rate constants of the reactions On the other hand, it was observed that the rate constants of decomposition of toluene, m-xylene[3], p-, m- and o-fluoro-toluene[4], and γ-picoline[5] were identical within 25 per cent (see Table 1) It was demonstrated that all these reactions were of the same type, namely,

$$RH \rightarrow R + H$$

The activation energy in these processes should be equal to the respective C—H bond dissociation energy, and it seems that the latter is constant for all the compounds listed above (see ref 4) Thus, the equality of all these rate constants is, in our opinion, the

Table 1 $RH \rightarrow R + H$

Compound	Rate constant interpolated to 804° C 10^3 sec $^{-1}$
Toluene	3 8
m-Xylene*	4 4
p-Fluoro-toluene	3 4
m-Fluoro-toluene	3 1
o-Fluoro-toluene	3 3
γ-Picoline	4 3

* The rate is divided by the statistical factor of 2

strongest argument in favour of the assumption of the constancy of the frequency factors in a series of similar decompositions

Recent studies of the pyrolysis of substituted benzyl bromides[6] provide additional evidence supporting this argument It was shown that the rate-determining step in the pyrolysis of benzyl-bromide and its derivatives is a unimolecular homogeneous dissociation process

$$C_6H_5\,CH_2Br \rightarrow C_6H_5\,CH_2 + Br,$$

and it was found that the rate of decomposition is nearly constant (within 25 per cent) for benzyl bromide, *m*-xylyl bromide, *p*- and *m*-chloro-benzyl bromides, and *p*- and *m*-bromo-benzyl bromides (see Table 2)

Table 2 $RBr \rightarrow R + Br$

Compound	Rate constant interpolated to 527° C 10^3 sec $^{-1}$
Benzyl bromide	46
m-Xylyl bromide	47
m-Chloro-benzyl-bromide	52
p-Chloro-benzyl-bromide	60
m-Bromo-benzyl-bromide	56
p-Bromo-benzyl-bromide	56

Some observations might be regarded as a generalization of the above rules to other series of similar reactions Thus C K Ingold and W S Nathan[7] estimated the activation energies for the hydrolysis of various substituted benzoic esters The graph of the estimated activation energies versus log *k* (*k* being the rate constant of hydrolysis) gives a straight line, proving that the frequency factors remain constant throughout the whole series These authors also directed attention to the results obtained by E G Williams and C N Hinshelwood[8] for the kinetics of benzoylation of various substituted anilines A similar plot of *E* versus log *k* obtained by the latter authors gave a straight line which was parallel to that obtained by Ingold and Nathan The idea of the constant frequency factors in a series of kindred reactions was developed further by L P Hammett[9], who devised a system of ρ- and σ-factors, ρ represents an entropy change constant for the same type of reaction, and σ represents the change in activation energy characteristic for each member of the series It has to be emphasized, however, that the regularities discussed above were observed in liquid-phase reactions, and one has to be careful in using them as a support for argument which applies to gas-phase reactions

Attention must be directed to a relationship frequently assumed between the activation energy of a process and its frequency factor This relationship is justified only for such series of reactions in which the variable parameter affects the reacting centre For example, by varying the solvent in which some process takes place, one affects both the energy and the entropy of activation, and both are changed in the same direction For the gas reactions, however, the relationship between the activation energy and the frequency factor seems to be fortuitous Due to technical limitations, we are forced to measure rates of reactions in a comparatively narrow range, in consequence, the accumulated experimental material sometimes indicates the existence of a relationship between two entities which has no real existence

We conclude that the frequency factors of unimolecular dissociation processes occurring in the gas phase seem to be unaffected by the variation in the structure of a molecule which does not affect the reacting centre, but that it depends on the type of reaction and on the structure of the reacting centre

Thanks are due to Prof M G Evans for helpful discussions

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Modified Carbobenzyloxy Groups in Peptide Synthesis

The 'carbobenzyloxy' method of peptide synthesis[1] has proved its value in many important syntheses Nevertheless, the practical difficulties still encountered in this field suggest that improved protecting groups should still be sought We have recently been examining benzyl chloroformates substituted in the benzene ring, and other closely related compounds, in the hope that the amino-acid and peptide derivatives might crystallize more readily and that other properties, such as stability and ease of removal of the protecting group, might differ in such a way as to increase the scope of this method of synthesis

α-Naphthyl carbinol reacted with phosgene to give a product which was coupled with glycine in the normal manner, giving carbo-α-naphthylmethoxyglycine (found C, 65 2 , H, 5 2 , N, 5 3 $C_{14}H_{13}O_4N$ requires C, 64 86 , H, 5 02 , N, 5 41 per cent), but this material began to decompose just below its melting point, liquefying at 136° The theoretical amount of carbon dioxide was evolved on hydrogenation The acid chloride was prepared by the action of phosphorus pentachloride and coupled with glycine ethyl ester, but difficulty was encountered in the purification of the product and of the carbo-α-naphthylmethoxyglycylglycine obtained by saponification, and no further derivatives were prepared

p-Tolyl carbinol yielded a liquid chloroformate which was coupled in the normal manner to give carbo-*p*-tolyloxyglycine (m p 93°), and carbo-*p*-tolyloxyglycine ethyl ester (m p 38°) (found C, 62 3 , H, 6 9 $C_{13}H_{17}O_4N$ requires C, 62 1 , H, 6 8 per cent) Treatment of the ester with hydrazine gave carbo-*p*-tolyloxyglycyl hydrazide (m p 120°) (found C, 55 7 , H, 6 4 $C_{11}H_{15}N_3O_3$ requires C, 55 7 , H, 6 3 per cent) These compounds appear to offer little advantage over the corresponding carbobenzyloxy derivatives *p*-Bromobenzyl chloroformate was then prepared from *p*-bromobenzyl alcohol, as a stable low-melting crystalline solid. With glycine it gave carbo-*p*-bromobenzyloxyglycine (m.p. 139°) (found: C, 41.8; H, 3.3. $C_{10}H_{10}O_4NBr$ requires C, 41.7; H, 3.5 per cent); treatment of the latter with phosphorus pentachloride followed by coupling with glycine ethyl ester gave carbo-*p*-bromobenzyloxyglycylglycine ethyl ester (m.p. 125°) in nearly theoretical yield (found: C, 45.3; H, 4.5. $C_{14}H_{17}O_5N_2Br$ requires C, 45.04; H, 4.56 per cent). With hydrazine, carbo-*p*-bromobenzyloxyglycylglycyl hydrazide was obtained (m.p. 180°) (found: C, 40.5; H, 4.3. $C_{12}H_{15}O_4N_4Br$ requires C, 40.12; H, 4.18 per cent). With glycine ethyl ester, *p*-bromobenzyl chloroformate gave carbo-*p*-bromobenzyloxyglycine ethyl ester (m.p. 74°) which yielded a hydrazide (m.p. 148°) (found: C, 39.9; H, 3.5. $C_{10}H_{12}O_3N_3Br$ requires C, 39.7; H, 3.85 per cent). Hydrogenation removed the protecting group from carbo-*p*-bromobenzyloxyglycine in the normal manner. All these materials have melting points higher than the corresponding carbobenzyloxy compounds, and in general they crystallize with greater ease. Derivatives of other amino-acids are being prepared.

Other modifications of the carbobenzyloxy group are being examined, but meanwhile the use of *p*-bromobenzyl chloroformate may be found advantageous in peptide synthesis.

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Epidermal Mitotic Activity and Oxygen Tension

The effects of anaerobic conditions on mammalian epidermis were first studied by Medawar[1], who developed an elegant technique for showing that this tissue can survive by anaerobic glycolysis alone, but that cell movement and division depend on "respiratory activity in the narrow sense". These conclusions, which apply to the rabbit, have now been confirmed and elaborated in the case of the mouse. A technique has been devised, using standard Warburg equipment, for the maintenance of ear epidermis from adult male mice in a phosphate-buffered saline with added glucose.

Five fragments of ear epidermis (*c.* 2.5 mm. × 5.0 mm.) were immersed in 4 ml. saline medium in each flask, the side arm containing 0.016 mgm. colchicine in 0.04 ml. solution. The manometers were gassed with oxygen, nitrogen, or oxygen/nitrogen mixtures as required, and the flasks were maintained at 38° C. After one hour, when all the mitoses originally present were judged to have passed the metaphase, the colchicine was tipped into the main compartment. The incubation was then continued for a further four hours, when the tissue was fixed for sectioning. The results are shown in Table 1.

Table 1. The average numbers of mitoses arrested by colchicine in unit lengths (1 cm.) of sections (7 μ thick) of mouse ear epidermis after 4 hr. incubation at 38° C. in phosphate-buffered saline with added glucose. Each figure is the average of 10 observations

Gas phase					
100% N_2	80% N_2/ 20% O_2	60% N_2/ 40% O_2	40% N_2/ 60% O_2	20% N_2/ 80% O_2	100% O_2
0.4 ± 0.10	2.2 ± 0.26	3.9 ± 0.27	5.5 ± 0.33	6.8 ± 0.34	8.3 ± 0.49

These figures indicate a direct linear relationship between epidermal mitotic activity and oxygen tension, and coincident observations on oxygen uptake (without colchicine) have confirmed that with increased oxygen tensions increased quantities of oxygen are absorbed (Table 2).

Table 2. $Q(O_2)$ of mouse-ear epidermis determined during 4 hr. incubation at 38° C. in phosphate-buffered saline with added glucose ($Q(O_2) = \mu l.$ oxygen consumed/mgm. dry wt./hr.). Each figure is the average of 8 observations

Gas phase		
80% N_2/20% O_2	40% N_2/60% O_2	100% O_2
1.18 ± 0.05	1.52 ± 0.06	1.83 ± 0.07

Evidently a direct linear relationship also exists between oxygen consumption and oxygen tension.

Confirmation is thus provided for the theory already advanced that epidermal mitotic activity depends on the energy derived from the aerobic metabolism of glucose[2,3]. If this is so, then by adding to the saline medium known catalysts of the tricarboxylic acid cycle, it should be possible to increase the oxygen consumption and hence the mitosis rate. The results of an experiment in which 0.02 *M* sodium glutamate was present in the saline medium are shown in Table 3.

Table 3. The influence of 0.02 *M* sodium glutamate on the numbers of mitoses arrested by colchicine in 4 hr. and on the $Q(O_2)$ of mouse-ear epidermis incubated at 38° C. in phosphate-buffered saline with added glucose and a gas phase of oxygen

Numbers of mitoses (5 observations)		$Q(O_2)$ (8 observations)	
without glutamate	with glutamate	without glutamate	with glutamate
6.7 ± 0.60	10.0 ± 0.75	1.83 ± 0.07	2.40 ± 0.13

It has already been established that glucose and oxygen exert their action on mitosis at a time immediately prior to the prophase, and that they are without effect once the prophase has begun[4]. This pre-prophase is evidently a critical time in the physiology of mitosis, and the name of 'antephase' has been suggested for it. The evidence so far available suggests that the energy required for mitosis must be built up in the antephase, and that once a division begins it can continue to completion in almost any circumstances short of the death of the cell. On one hand, the numbers of mitoses developing can be increased by stimulating the rate of energy production from glucose oxidation, while, on the other, they can be depressed by anaerobic conditions and by such known inhibitors of cellular metabolism as cyanide, fluoride, and dinitrophenol[5]. However, none of those substances which stimulates or depresses mitotic activity in this way appears to have any substantial effect on the course of a cell division once it has begun.

A full account of the techniques devised for this work and of experiments with catalysts and inhibitors will be published in due course.

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Habitat of *Balanus amphitrite* var. *denticulata* in Britain

In a recent communication, M W H Bishop[1] suggests that since *Balanus amphitrite* of a variety conforming to Broch's var *denticulata* has been found on the southern coasts of Britain, this represents the northern limit of distribution of this tropical and Mediterranean variety We should like to add some further detail to the existing records and to contribute additional ones which point to some modification of Bishop's general conclusion

The persistence of this species at Shoreham, where it was first collected by Dilwyn John in 1937 together with a new species of *Hydroides* described by Monro[2], appears to be due entirely to the entry of warm water from condensers of the local power station This warmed water flows through a cooling pond some 10,000 sq yd in area, and is largely retained here and in the adjacent Shoreham harbour canal (Fig 1), where the water-level rises and falls some 2 ft owing to the opening of locks (*G*, Fig 1) on spring and neap tides *B amphitrite* occupies the zone of this tidal fluctuation in considerable numbers (500–1,000 per sq metre) but extends below it only to a limited extent owing to competition by other sessile organisms, for example, *Botrylloides*, *Bugula neritina* and sessile diatoms Small numbers of healthy individuals occur as far away as the lock gates of the harbour The zone of settlement during summer extends into the tidal arms of the estuary on floating buoys, etc , and it has been recorded on experimental panels on the Palace Pier, Brighton, some three miles to the east Nevertheless, these settlements outside the canal are not permanent, examinations in early spring showing many dead shells and scars There is no evidence elsewhere along the south or south-east coasts of Britain of any persistent or considerable settlement of the species Temperatures have been recorded regularly within the cooling pond, which is normally uniform within 1° C , and the lowest record (winter 1946–47) was 7° C In cold weather the higher load on the station leads to a greater transfer of heat to the circulating water and so to more equable conditions than prevail outside Breeding in this very limited population occurs regularly every year and is ample to maintain the species (1947–50) Fertilizations occur during March–September and settlements during May–August In summer, temperatures of 25° C or higher are commonly encountered

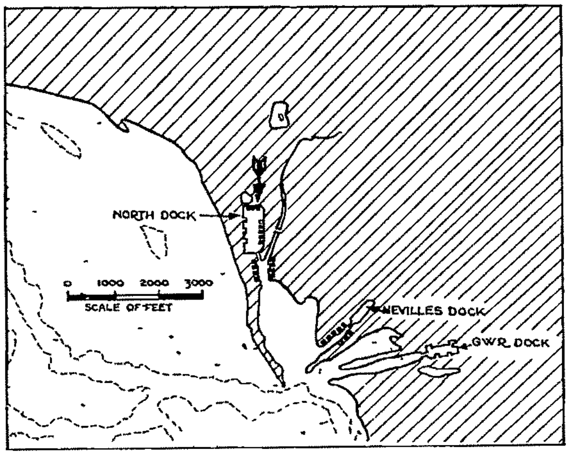

Fig 2 Settlement of *Balanus amphitrite* at Llanelly Condenser discharge indicated by arrow Settlements marked as in Fig 1

Records in the Plymouth area show a similar phenomenon , we have taken specimens on several occasions on piles in the immediate vicinity of the power station discharging below Laira Bridge in the River Plym but not elsewhere The species is, however, less abundant locally, though judged from Bishop's observations rather more widespread, than at Shoreham This we believe to be due to more rapid dispersal of the warmed effluent, and milder winter temperatures in the sea outside

Two additional records have been obtained, at Llanelly and Swansea (August 1949) At Llanelly a warmed discharge enters the North Dock , *Balanus amphitrite* was found here and in Neville's Dock, a blind basin 600 yd distant (Fig 2) At Swansea it occurs on buoys, piles, etc , in the Queen's Dock, where again the water is artificially warmed It does not appear to be present elsewhere along the coast In all specimens examined the labrum indicates that the var *denticulata* of Broch[3] is present

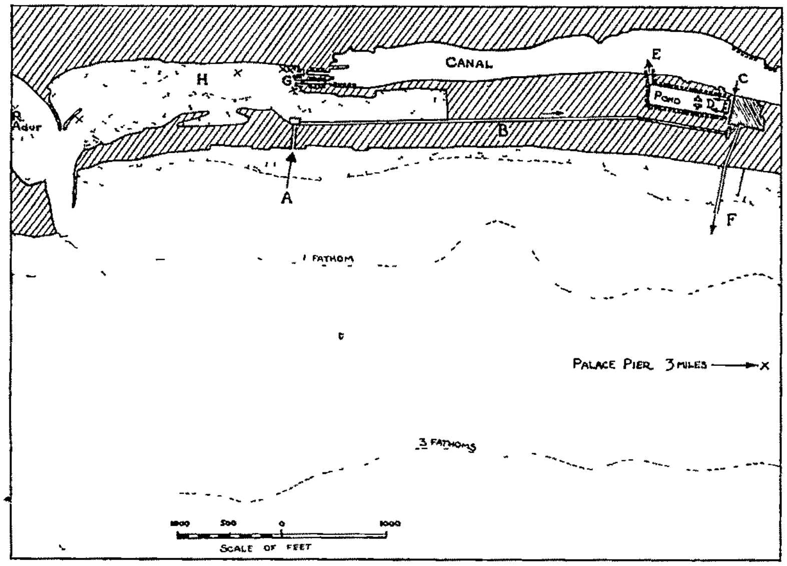

Fig 1 Shoreham Harbour Canal Water from the sea is pumped from *A* along the duct *B*, where it joins water from the canal entering at *C* and is passed into the condensers Warm effluent is discharged both out to sea at *F* and into the cooling pond at *D*, whence it re-enters the canal by a conduit *E* Persistent settlements indicated by thick broken lines Transient settlements marked *X* Water movement indicated by arrows

Thus the habitat of *Balanus amphitrite* in Britain is localized and artificial , the species is in no sense naturally established The spread of *Elminius modestus*, which has now extended its range north of the Humber to the Blyth Estuary[4] on the east coast and into the Solway and Loch Ryan on the west[5], offers a remarkable contrast

Both *Elminius modestus* and *Balanus amphitrite* are sometimes found infected by *Hemioniscus balani*, the incidence of infection in some areas of the South Devon and South Wales coast being greater than 50 per cent

We are indebted to Dr J P Harding for directing our attention to the original specimen from Shoreham Harbour and to the British Electricity Authority for giving us facilities in examining the vicinity of its condenser effluent at Shoreham We also wish to thank the Dockmaster at Llanelly and the Superintendent of the Queen's Dock, Swansea, for access and useful information

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Effect of Gamma-BHC Seed Dressings on the Germination of Cereals

DURING the development of the combined fungicidal/insecticidal seed dressing 'Mergamma', containing organomercurial and gamma benzene hexachloride, it became apparent that levels of gamma benzene hexachloride on the seed, safe in practical tests in the field and in box tests in soil, were markedly phytotoxic in conventional germination tests in sand or on damp filter-paper This communication gives a brief summary of an extensive programme of work on this aspect with wheat, barley and oats

(1) In the field, grain treated with gamma benzene hexachloride and sown at two to four bushels per acre germinated and grew entirely satisfactorily provided excessive dosage was avoided 500 parts per million of the chemical on the seed gave no appreciable check to emergence and growth 500–1,000 p p m sometimes slightly checked early growth, the effect was small and disappeared by the fifth or sixth week, yields were not affected Doses much higher than 1,000 p p m did not invariably check emergence and growth

Other results from Canada and the United States indicated that 500–1,000 p p m could be safely used at seeding-rates lower than two bushels per acre

(2) In box tests with soil, the germination of seed which had been treated with gamma benzene hexachloride at 500 p p m or less was not adversely affected by storage for twelve months

(3) In germination tests on damp filter paper or in sand at doses of 250–500 p p m, most seeds germinated normally, even if rather slowly in some instances Abnormal effects on growth, varying considerably in degree, were also observed These consisted of checking and thickening of the shoot and characteristic clubbing of the primary roots Even when these effects were severe, secondary roots were produced in the normal manner

As doses were increased above 500 p p m the effects became more pronounced, leading to the eventual suppression of normal growth

The amount of gamma benzene hexachloride necessary for control of wireworm attack on wheat, barley and oats in the field is of the order of one ounce per acre, giving about 500 p p m and 250 p p m at sowing-rates of two bushels and four bushels per acre respectively These levels are satisfactory in the field, but are in the range that causes abnormality in sand or filter-paper germination tests Seed-dressings incorporating gamma benzene hexachloride are coming into general use, and seed may be submitted to standard germination tests after treatment In such cases the appearance of abnormalities in these tests will not necessarily imply unsuitability of the seed for use in the field

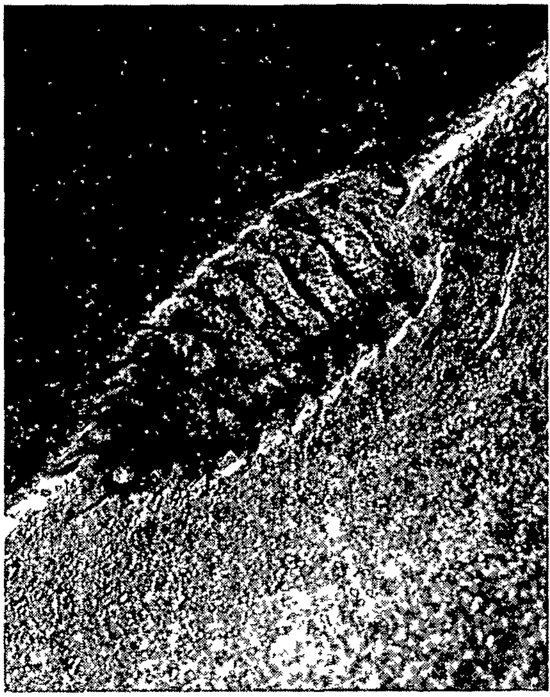
H R JAMESON
I W McC CALLAN

Hawthorndale Laboratories,
Imperial Chemical Industries, Ltd,
Bracknell, Berks
Nov 15

Imprint of a Crustacean in an Alloy Casting

THE accompanying photograph shows the surface of a block of aluminium-silicon alloy cast in a sand-mould at the Royal Aircraft Establishment, Farnborough, Hants

Although the temperature of the liquid metal was about 700° C, the casting has retained a sharply defined impression of a small creature—apparently a woodlouse—which happened to be on the surface of the sand



[Crown copyright reserved

To form this concavity the metal must have chilled immediately on contact with the creature, no remains of which could be found

I felt these facts would be worth putting on the scientific record because of their possible application to the study of fossil formation in hot rocks

I am grateful to the Editor of the *R A E News* for permission to use the photograph

CHAPMAN PINCHER

Daily Express,
Fleet Street,
London, E C 4
Feb 19

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, March 27

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W 1), at 6 30 p m —Mr D A J Maddock "Magnetic Amplifiers"

Wednesday, March 28

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m — Dr W J Martin "A Comparison of the Trends of Male and Female Mortality"

British Iron and Steel Research Association (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m —Dr U R Evans, F R S "Fundamental Studies of Corrosion and their Importance to the Engineer" *

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, Mosley Street, Manchester), at 5 45 p m —Dr J W Baker "Chemical Curricula in the Universities To-day"

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 15 p m —"Factors in Distribution affecting the Quality and Nutritional Value of Foodstuffs", 3, "Fruit and Vegetables"

Society of Chemical Industry, Birmingham Section of the Chemical Engineering Group (at the University, Edmund Street, Birmingham), at 6 30 p m —Mr A H Loveless "Relation of the Chemical Engineer to the Chemist and Production Engineer in Industry"

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p m —Mr A Green "Some Uses of Electrical Capacity in Industrial Measurement"

Chemical Society, Irish Republic Section (in the Chemistry Department, University College, Dublin), at 7 45 p m —Prof T S Wheeler "William Higgins (1763–1825)"

Thursday, March 29

Physical Society, Optical Group (in the Small Physics Lecture Theatre, Imperial College of Science and Technology Imperial Institute Road, London, S W 7), at 2 30 p m —Tenth Annual General Meeting , at 2 45 p m (in the Physics Department)—Scientific Papers

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m —Dr J B Birks "Nuclear Scintillation Counters"

Thursday, March 29—Tuesday, April 3

British Psychological Society (at The University, Liverpool) — Annual General Meeting

Thursday, March 29—Saturday, March 31

Physical Society (in the New Arts Theatre and in the Department of Physics, University College, Swansea) —Symposium on 'Some Aspects of Discharge Physics"

Friday, March 30

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p m —Annual General Meeting

Plastics Institute (at the Engineers' Club, Albert Square, Manchester), at 6 45 p m —Mr H A Nancarrow 'Rheology'

Royal Photographic Society, Kinematograph Section (at 16 Prince's Gate, London, S W 7), at 7 p m —Sir Robert Watson-Watt, F R S "Operational Research in the Film Industry"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Lecturer (Grade III) in Geography—The Secretary, The University, Birmingham 3 (March 31)

Chemists at a Ministry of Supply research and development establishment in the London area Senior Scientific Officer or Scientific Officer (Ref F 129/51A), (*a*) Analytical Chemist with experience in microbiology and physical methods, (*b*) Physical Chemist or Physicist for work on surface phenomena and the investigation of the properties of metallic films and coatings, (*c*) Physical Chemist or Physicist for work on the determination of physical properties or in the preparation of novel ceramic materials , Experimental Officer or Senior Experimental Officer (Ref F 130/51A), (*a*) Chemist or Chemical Engineer with experience of the control of gases on an industrial scale, (*b*) Chemist with experience of gas analysis, (*c*) Chemists experienced in factory development work, (*d*) Physical Chemist or Physicist with interest in work on ceramic materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (March 31)

Graduate Physicist to take charge of works instrumentation in the Birmingham District Works—The Divisional Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham 3 (March 31)

Mechanical Engineers (Experimental Officer grade) at a Ministry of Supply design establishment in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 155/51A (March 31)

Metallurgists at Ministry of Supply research establishments in or near London Scientific Officers (Ref F 206/51A), (*a*) Physical Metallurgist with research experience in metallography, (*b*) Metallurgist with research experience particularly in connexion with the hot and cold processing of metals , Experimental Officer or Assistant Experimental Officer (Ref F 207/51A), (*a*) preferably with experience in a research field, of the casting and working of metals, (*b*) with experience in a research field, of electro-deposition, or investigation of the properties of metallic films and coatings—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (March 31)

Physicists and Electrical Engineers (Senior Scientific Officer and Experimental Officer grades) at Ministry of Supply experimental and development establishments, for work on outdoor instrumentation—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 95/51A (March 31)

Professional Engineers in many departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W 1, quoting No 3225 (March 31)

Professor of Physiology at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (March 31)

Research Assistant in the Department of Chemistry, University College, Dundee, to undertake work sponsored by the Department of Scientific and Industrial Research on the thermodynamics of solutions—The Secretary, The University, St Andrews (March 31)

Research Assistant (with an honours degree in physics) in the Department of Textile Industries—The Registrar, The University, Leeds 2 (March 31)

Scientists (honours graduates with experience in medical or veterinary research and specialized in bacteriology, biochemistry, biophysics, immunology, virology or pathology) at a Ministry of Supply research establishment in south-west England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting G 339/50A (March 31)

Technical Officer (man or woman) in the Electrical Engineering Section of the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 114/51A (March 31)

Warden (graduate, who will be required to take some part in university teaching) of Stephenson Hall—The Registrar, The University, Sheffield (March 31)

Physicist or Electrical Engineer (Principal Scientific Officer grade) with a high-class honours degree with research experience in telecommunications with special emphasis on all radio telephony methods and high-speed telegraphy, a Physicist (Senior Scientific Officer grade) with a high-class honours degree with research experience and a considerable knowledge of electronic circuitry, and a Physicist or Electrical Engineer (Senior Scientific Officer grade) with a high-class honours degree with experience in telecommunication research with emphasis on radio telephony and high-speed telegraphy problems, in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No S 4011/51 (April 5)

Aeronautical Engineers (Principal Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough, to lead the Armament Installation Section, covering design and development of bomb carriers and associated equipment, development of aircraft armament installations, and stressing and strength testing of armament stores for carriage in aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 161/51A (April 7)

Agronomist (Ref G 7/51A) with university degree in agriculture and special qualifications in crop husbandry, and considerable experience of such work on a University farm or other experimental stations, a Horticulturist (Ref G 17/51A) with university degree in agriculture and sound practical experience, and a Superintendent of Livestock (Ref G 103/51A) with a degree or diploma in agriculture and good practical experience in livestock management, etc , under the Government of Cyrenaica—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (April 7)

Histologist to collaborate in researches on endocrinology of lactation and reproduction and other research projects involving histological studies—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 51/1 (April 7)

Mechanical and Electrical Engineers, grades II and III, in the Ministry of Supply (Ref No C 149/51A), Mechanical and Electrical Engineers for (*a*) the maintenance and general service of large factories, (*b*) the control and organization of inspection of engineering and aeronautical equipments and machine tools, (*c*) administration duties concerned with production, (*d*) design and development work , Mechanical Engineers for (*e*) light or heavy engineering planning and production, (*f*) development of production processes, (*g*) time and motion study , (Ref No D 72/51A), Electrical Engineers for (*h*) electronics—research and inspection, (*i*) radio and radar equipment—research and inspection—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (April 7)

Physicist in the Carbonization Section of the Central Research Establishment at Stoke Orchard, Cheltenham, to carry out research into the physical properties of fluids—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/300 (April 7)

Professor of Preventive Medicine, and a Senior Lecturer in Animal Production, in the Faculty of Veterinary Science of the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (April 7)

Lecturer in Mathematics (applied mathematics), an Assistant Lecturer in Zoology, and an Assistant Lecturer in Physics—The Principal, Royal Holloway College, Englefield Green, Surrey (April 9)

Assistant Professor of Engineering—The Registrar, University College, Singleton Park, Swansea (April 11)

Research Fellowship in Photographic Science—The Clerk to the Governors, Imperial College of Science and Technology, Prince Consort Road, London S W 7 (April 12)

Lecturer in Mathematics in the Training Department—The Warden, Goldsmiths' College, New Cross, London, S E 14 (April 14)

Senior Lecturer or Lecturer in Biochemistry—The Registrar, The University, Sheffield (April 14)

Senior Research Officer or Research Officer, Physical Chemist or Biochemist, in the Biochemical Unit, Wool Textile Research Laboratory, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting No 3311 (April 14)

Biologist (to specialize in the investigation of grass diseases as they affect sports turf), and an Advisory Officer (with a recognized diploma or degree in botany or agriculture)—The Director, St Ives Research Station, Bingley, Yorks (April 15)

Professor of Botany at Rhodes University College, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (April 15)

Lecturer in Physiology—The Secretary, Queen's University, Belfast (April 16)

Ramsay Memorial Fellowships for Chemical Research—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W C 1 (April 17)

Assistant Lecturers (2) in the Department of Zoology—The Registrar, University College, Cathays Park, Cardiff (April 20)

Readership in Physics at St Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W C 1 (April 23)

Shell Research Studentship in Chemical Engineering—The Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 25)

Assistant Lecturer (honours graduate in physics or electrical engineering) in Audiology—The Registrar, The University, Manchester 13 (April 28)

Assistant Lecturers (3) in Physics—The Registrar, The University, Manchester 13 (April 30)

I C I Research Fellowships in Physics, Chemistry, Metallurgy, Engineering or an allied subject—The Registrar, University of Wales, University Registry, Cathays Park, Cardiff (April 30)

Principal—The Secretary, North of Scotland College of Agriculture 41½ Union Street, Aberdeen (April 30)

Assistant Lecturer in the Department of Applied Mathematics—The Registrar, The University, Liverpool (May 1)

Readership in Mathematics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W C 1 (May 1)

Senior Lecturer in Theoretical Physics—The Secretary of Faculties, University Registry, Oxford (May 1)

Assistant Director (chemical engineering) and an Assistant Director (plastics and high polymers) at the National Chemical Laboratory, Poona—The Secretary, Council of Scientific and Industrial Research, 'P' Block, Raisina Road, New Delhi, India , or the High Commissioner for India, General Department, India House, Aldwych, London, W C 2, quoting No 4/55D (New Delhi, May 5)

Assistant Lecturer in Pure Mathematics—The Registrar, University College, Hull (May 5)

Lecturer in Mathematics, a Senior Lecturer in Organic Chemistry, and a Lecturer in Physics, at the New England University College (University of Sydney), New South Wales—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 14)

Boots Research Scholarship at the Long Ashton Agricultural and Horticultural Research Station—The Registrar, The University, Bristol (May 31)

Geologists at the Geological Survey and Museum—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No S 168/51 (May 31)

Lecturer in Veterinary Preventive Medicine, and a Lecturer in Veterinary Pharmacology—The Registrar, The University, Liverpool (May 31)

Lecturers and Assistant Lecturers in Experimental or Theoretical Physics—The Secretary, The University, Aberdeen (June 1)

Chemist (with first-class honours) for work on the chemistry of wool keratin and allied proteins, and a Chemist (with first- or second-class honours) to develop radio-tracer methods for protein analysis—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6

Head of the Department of Civil and Mechanical Engineering—The Principal, Technical College, Queen Street South, Huddersfield

Metallurgists, Physicists and Physical Chemists, to undertake a wide range of duties in normal and radioactive metallurgy, including physical metallurgy, crystallography, physics, properties of metals and alloys, corrosion, powder metallurgy and chemical thermodynamics, at Risley, near Warrington, Salwick, near Preston, and Windscale Works, Sellafield—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs (stating post applied for and location preferred)

Physical Chemist (with an honours degree in science, and preferably postgraduate experience in physical chemistry) for work on problems relating to fundamental and technical aspects of wool—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6

Professor of Mathematics—The Secretary, Royal Technical College, George Street, Glasgow, C 1

Research Assistant in the Department of Botany—The Clerk, Birkbeck College, Breams Buildings, London, E C 4

Research Chemists in the Division of Atomic Energy (Production), Applied Research Department, Windscale Works, Sellafield, to undertake chemical and radiochemical research work associated with atomic energy development—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington Lancs, quoting A R D/2/8

Scientific Officer (temporary), for work on beans—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Colonial Office Colonial Research, 1949–50 Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides, Fungicides and Herbicides Committee, Colonial Economic Research Committee (Cmd 8063) Pp 155 (London H M Stationery Office, 1950) 3*s* 6*d* net [211

British Standard 1428, Part A 1 1950, Carbon and Hydrogen Combustion Train, Pregl Type Microchemical Apparatus, Group A, Combustion Train for the Determination of Elements Pp 21 3*s* net British Standard 1428, Part D 2 1950, Washout Pipettes Microchemical Apparatus, Group D, Volumetric Apparatus Pp 13 2*s* net British Standard 1428, Part D 3 1950, Micro-Nitrometers, Pregl Type Microchemical Apparatus, Group D, Volumetric Apparatus Pp 12 2*s* net British Standard 1583 1950, One-Mark Bulb Pipettes Pp 12 2*s* net (London British Standards Institution, 1950) [711

Overseas Food Corporation Annual Report and Statement of Accounts for the Year ended 31st March 1950 Pp vi+121 (London H M Stationery Office, 1950) 3*s* 6*d* net [711

Transactions of the Royal Society of Edinburgh Vol 62, Part 1, No 1 On the Developmental Processes in Mammary Glands and other Epidermal Structures By B I Balinsky Pp 31+3 plates (Edinburgh and London Oliver and Boyd, Ltd , 1950) 9*s* [711

Reports of the Commonwealth Economic Committee Thirty-fourth Report A Survey of the Trade in Fertilisers Pp vi+126 (London H M Stationery Office, 1950) 3*s* 6*d* net [711

Other Countries

Federal Security Agency Public Health Service An Index of Tumor Chemotherapy a Tabulated Compilation of Data from the Literature on Clinical and Experimental Investigations By Helen M Dyer Pp iii+329 (Bethesda, Md National Cancer Institute, 1949) [211

Beach Erosion Board Corps of Engineers Technical Memorandum No 19 Submarine Topography and Sedimentation in the Vicinity of Mugu Submarine Canyon, California By D L Inman Pp v+45 Technical Memorandum No 20 Beach Cycles in Southern California By Francis P Shepard Pp v+26 (Washington, D C Government Printing Office, 1950) [211

World Health Organization Technical Report Series No 25 Expert Committee on Health Statistics , Report on the Second Session, including Reports on the First Sessions of the Subcommittees on Definition of Stillbirth, Registration of Cases of Cancer, Hospital Statistics Pp 36 2*s* , 25 cents Technical Report Series No 26 Expert Committee on Antibiotics , Report on the First Session Pp 12 9*d* , 10 cents Technical Report Series No 27 Expert Group on Prematurity , First Report Pp 12 9*d* , 10 cents (Geneva World Health Organization , London H M Stationery Office, 1950) [711

Canada Department of Mines and Technical Surveys Geological Survey of Canada Bulletin 16 The Groundhog Coalfield, British Columbia By A F Buckham and B A Latour Pp v+82 75 cents Memoir 253 Fiedmont Map-area, Abitibi County, Quebec By L P Tremblay (No 2491) Pp vii+113 75 cents Memoir 254 Alexo and Saunders Map-areas, Alberta By O A Erdman (No 2492) Pp vii+100 1 dollar (Ottawa King's Printer, 1950) [711

Canada Department of Mines and Technical Surveys, Mines Branch The Mining Laws of Canada a Digest of Dominion and Provincial Laws and Regulations affecting Mining Prepared by Arthur Buisson Fourth edition Pp ix+133 (Ottawa King's Printer, 1950) 50 cents [711

Catalogues

Chemistry from the Invention of Gunpowder to the Discovery of Radium , Early Medical Books (Catalogue 16) Pp 48 (London E Weil, c/o National Provincial Bank, 9 Market Place, N W 11, 1950)

Metal Unit Laboratory Furniture Pp 24 (Chadwell Heath Baird and Tatlock (London), Ltd , 1950)

Wild-Barfield Oval Muffles (M 148/OM) Pp 2 (Watford Wild-Barfield Electric Furnaces, Ltd , 1950)

Books Ancient and Modern on a large Variety of Subjects (Catalogue 708) Pp 98 (London Francis Edwards, Ltd , 1950)

Nivoc Automatic Aperiodic Balance Pp 8 (London and Birmingham W and J George and Becker, Ltd 1950)

Direct Reading 'Auto-Photometer' (Sheet 464) Pp 2 (London Everett Edgcumbe and Co , Ltd , 1950)

Autotechnicon an Integrated System for Histologic Processing Pp 16 (New York Technicon International, Ltd , Wallington, Surrey 7 Lytton Gardens, 1950)

The Symbol of Power in Industry Pp 8 (Manchester and London Lancashire Dynamo and Crypto, Ltd , 1950)

'Teddington' Type TJ Automatic Pilot Device (Publication AT/25A) Pp 4 (Sunbury British Thermostat Co , Ltd , 1950)

NATURE

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Of nature trusts the Mind that builds for aye."—Wordsworth

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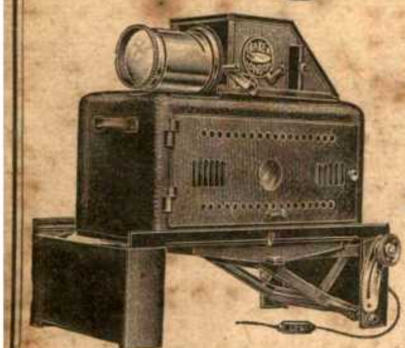

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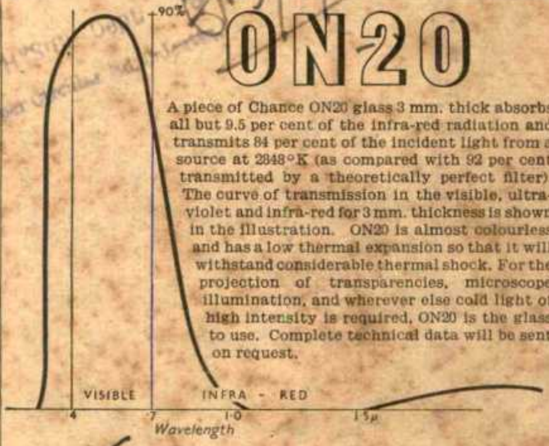

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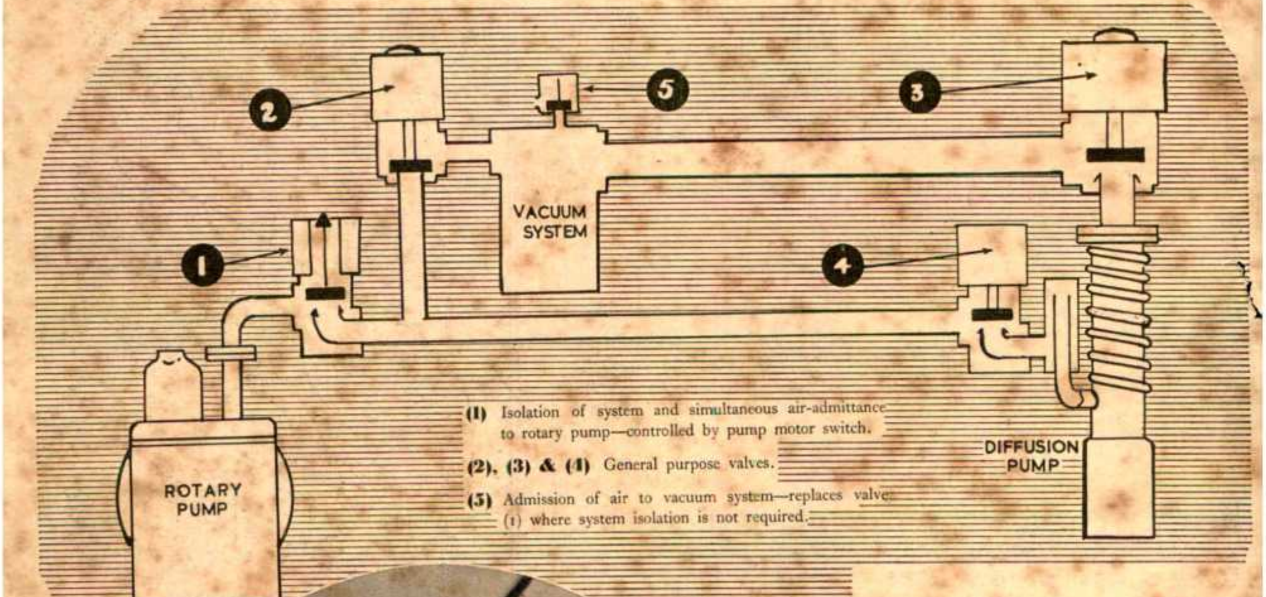

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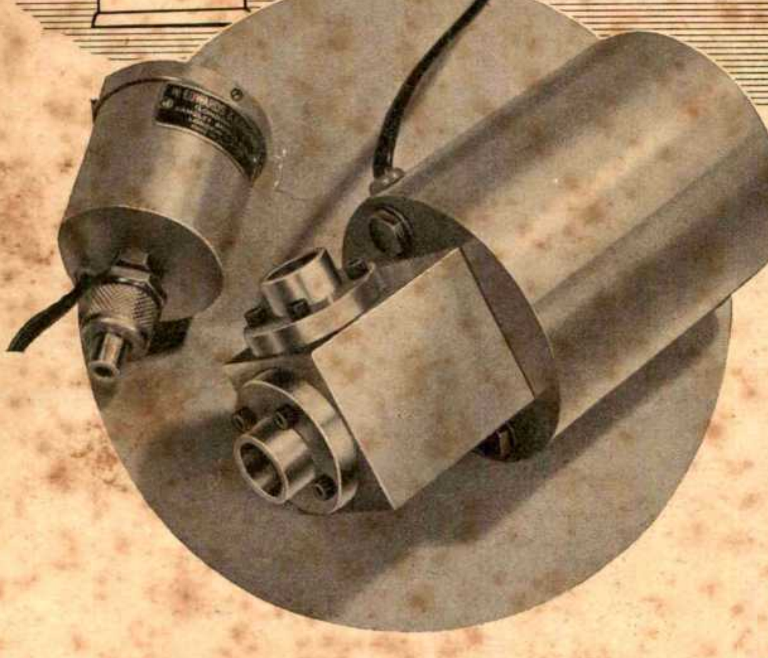

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SOUND AND VISION BROADCASTING IN GREAT BRITAIN

THE sound broadcasting service of Great Britain has been developed during the past twenty-five years or more with the objective of providing as large a proportion of the population as possible with a regular and efficient service Up to the present time, this broadcasting has been conducted within the long and medium wave-length bands, and the regional scheme of twin transmitters in various parts of the country was introduced to supply two distinct services which have now become identified as the 'Home Service' and the 'Light Programme' More recently, a 'Third Programme' has been added within the medium wave-length band In March 1950 the wave-lengths of many of the broadcasting stations in European countries were adjusted to conform to a new plan which was drawn up at an international conference held in Copenhagen in 1948 This plan allocated to the United Kingdom the exclusive use of one long wave and two medium waves, with an additional eleven medium waves shared with other countries The re-arrangement of wave-lengths in accordance with the Copenhagen agreement represents an improvement on the Lucerne plan of 1933, and has made it possible to extend the area which the 'Third' programme can cover from its former figure of 55 to about 70 per cent of the population of Great Britain, as compared with 92 and 98 per cent respectively for the 'Home' and 'Light' programmes But, as is pointed out in the Beveridge Report on broadcasting*, the dominant factor in all European broadcasting is the insufficient supply of long and medium wave-lengths in relation to the demands made for them This arises from the character of Europe as a collection of independent States in a restricted area, and for the most part densely populated and using different languages The physical conditions of broadcasting in the United Kingdom are quite different from those of countries such as Australia and New Zealand, and of the two major divisions of North America

Below the medium wave-band in the radio spectrum, there is the wave-length range from 10 to 100 metres, commonly referred to as the 'short-wave band'. While some portions of this band are used for broadcasting on a continent- or world-wide basis, and in tropical regions, other portions of the band are extensively used for long-distance radio communications of all types The allocation of all short wave-lengths is still the subject of discussion on an international basis, and moreover they do not provide a means of improving the national broadcasting conditions referred to above

It is with all the above considerations in mind that the Beveridge Committee has recommended that the B B C should give increased and urgent attention to the development of a scheme for the exploitation of what is termed 'higher-frequency broadcasting' using frequencies greater than 30 Mc /s., corresponding to wave-lengths less than 10 metres The Committee points out that by using such shorter waves and the technique of frequency modulation, the United States has been enabled to find full and free expression of their broadcasting requirements through stations which are more than twice as numerous as the fifteen hundred daily newspapers published there

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* Report of the Broadcasting Committee, 1949 (Cmd 8116) Pp vii+327 (London H M Stationery Office, 1951) 6s 6d net

With full knowledge of the practice and trend of development in America, however, the British Broadcasting Corporation has not been idle in this field The Corporation's engineers have, for some time past, been conducting at its station at Wrotham experiments to ascertain the effective range of transmission of waves at a frequency of about 90 Mc /s , and to compare the advantages and disadvantages of the two chief alternative methods of modulation, known as amplitude and frequency modulation (A M and F M) respectively The Committee was given to understand that the B B C. would soon be ready to formulate a practical scheme of development of this technique of higher-frequency sound broadcasting, designed first and foremost to provide a more satisfactory service of reception in large areas of Great Britain which are at present badly served by the medium- and long-wave programmes The Committee points out, however, that in its view an equally important objective in the development of broadcasting on higher frequencies is that of making possible a greater diversity and independence of programmes In brief, the future development on these frequencies should make it possible not merely to give the existing B B C programmes to people who now fail to get them, but also to establish local stations in Great Britain with independent programmes of their own

The development of sound broadcasting on very high frequencies is not without some technical problems As is mentioned in the Post Office memorandum appended to the Beveridge Report, the use of such frequencies is being explored and developed not only for broadcasting, but also for other radio services including air navigation, radio links in the public telephone service, and for the use of the police and the fighting services It is a characteristic of very short waves that, under normal conditions, the effective area covered by each station is limited to something not much greater than the optical range This means that high aerial systems are needed at the transmitting stations to secure as great a range as possible Conversely, the limitation of range means that a number of stations at suitable geographical separation can use the same frequencies without causing mutual interference.

In order to appreciate fully the possibilities of broadcasting on very high frequencies, it is recommended that the existing plan of the B B C should be revised so as to provide for the immediate installation of a sufficient number of stations in suitable localities, and for the development of many local stations if experiment proves their value In making these proposals for expediting the development of higher-frequency broadcasting in Great Britain, the Beveridge Committee appeared to be very conscious of the many highly technical problems involved; and it was presumed that the B B C would consult, as seems desirable, such bodies as the Scientific Advisory Committee and the Television Advisory Committee The continuance of the latter with wider terms of reference to cover high-frequency broadcasting as well as television is recommended in the report Furthermore, since such developments as are envisaged will involve replacing or modifying the receiving sets of those listeners who are to profit by them, it is important that the manufacturers of radio equipment should be kept informed as completely as possible of the trend of progress with the object of ensuring that the cost of future receiving sets is as low as possible

The Beveridge Committee received much evidence dealing with television , and its report contains a discussion of some of this material, with the principal objects of discovering the similarities and differences between television broadcasting and sound broadcasting, and of establishing the policy to be adopted for television viewing at home and for showing in public places such as cinemas On the former point, it is recommended that while it would be wrong to develop television as an off-shoot of broadcasting, both the sound and television broadcasting services should be controlled by the same authority A conclusion on the second point involves arriving at a proposal which is mutually acceptable to the B B C and the cinema interests , and the report suggests that, provided suitable wave-lengths can be made available for the public showing of television, the Postmaster General should be prepared to license their use by responsible organizations established for this purpose on approved financial terms and on condition that the resulting pictures are made available to the B B C

The report contains details of the B B C 's five-year plan for a nation-wide service of television which was approved by the Government and announced by the Postmaster General in November 1949 The scheme involves the division of the radio-frequency band of 41–68 Mc /s (wave-lengths 7 3–4 4 m) into five channels for the use of five high-power transmitting stations in England, Wales and Scotland To supplement these, five medium-power stations sharing the same channels will be erected in various parts of England, Scotland and Northern Ireland The high- and medium-power stations in each channel will be separated geographically by an adequate distance to avoid mutual interference, which will be further reduced by the use of vertical and horizontal polarization for the high- and medium-power transmissions respectively If the progress aimed at is maintained, the whole plan should be in full operation by the end of 1954 , and this will bring 78–88 per cent of the population of Great Britain physically within reach of television viewing on one or other of the two distinct standards of reception envisaged While this leaves considerable areas of the country unprovided for, it is known from experience already available that viewing will still be possible outside the limits of first- and second-class reception. Indeed, as the report states, there are some 30,000 television sets licensed beyond this range from the two transmitting stations already in operation in London and Birmingham

In connexion with school broadcasting, the Beveridge Report encourages the B B C to explore the possibility of supplementing the sound programme with television for instructional purposes

Reverting to the sound broadcasting service, and the desire to make this available to practically every home in Great Britain, it is relevant to conclude by a reference to the relay exchange system, to which some consideration was given by the Beveridge Committee Under this system, known also as wire broadcasting, programmes picked up at a central point or exchange are distributed over a special wire network to listeners subscribing to the system The programmes may be picked up at the exchange either by radio or by direct wire from the B B C , and the distribution may be effected either by the use of a suitable carrier wave on which is impressed the sound modulation, or the latter, as an audio-frequency signal, may be transmitted direct to the listener, who then merely requires a suitable loud-speaker for reception One of the chief advantages of this system is that the listener is not subject to local interference or the corresponding difficulties of reception in a bad area The main receiving station can be suitably located and provided with a very efficient aerial system, so as to ensure that a good-quality signal is supplied to the wire network But while these advantages can be achieved in populous districts, the Beveridge Report makes it clear that the relay system is not considered to be the obvious solution to the problem of improving reception conditions in sparsely populated areas generally On this point, however, it is recommended that the B B C , on its technical side, should be asked to report whether there are in fact, any isolated areas or areas of bad reception which can be covered better by relays than by radio The results of such an investigation may affect a future decision as to whether relay services, at present operated by private enterprise, should be taken over by the Postmaster General as part of the attempt to raise to a reasonable standard the listening conditions in every part of Great Britain The present conditions of the licence given to relay service operators impose limitations on the time devoted to the distribution of programmes received from abroad, but the Committee points out that a listener with an ordinary receiving set is not tied to the B B C programmes at all, and it sees no reason to place a greater restriction on the listener who prefers for his personal convenience the relay system

Summing up, it would appear that the recommendations of the Beveridge Committee, so far as they concern technical aspects of broadcasting in Great Britain, are both reasonable and sound Their acceptance and implementation would go a considerable way towards achieving the object of the British Broadcasting Corporation, namely, to enable everyone in Great Britain to receive broadcasting and television services which are both technically adequate and of reasonable diversity

BIOLOGY IN "CHAMBERS'S ENCYCLOPÆDIA"

Chambers's Encyclopædia
New edition Vol 1 A–Autonomy Pp xix+848 Vol 2 Autun–Camorra Pp xv+816 Vol 3 Camouflage–Confession of Faith. Pp xiv+840 Vol 4 Confirmation–Educational Psychology Pp xv+820. Vol 5 Edward–Franks Pp xiv+856 Vol 6 Franquelin–Heine Pp xv+824 Vol. 7 Heinrich–Izvolsky Pp xiv+820 Vol 8 J–Majesty Pp xv+840 Vol 9 Major–New York Pp xv+856 Vol 10 New Zealand–Pola Pp xv+824 Vol 11 Poland–Rosicrucians Pp xv+840 Vol 12 Roskilde–Spahi Pp xv+796 Vol 13 Spain–Tsushima Pp xv+792 Vol 14 Tuamoto–Zygote. Pp xiv+856 Vol 15 Indexes and Maps Pp x+815 (London George Newnes, Ltd , 1950)
15 vols , £42 10*s* 0*d*

AN accurate picture of the biological contributions in a series of volumes conceived and executed on so grand a scale as "Chambers's Encyclopædia" is not easy to paint It could be attempted by citing a long list of the distinguished contributors and by tabulating the subjects dealt with in their alphabetical arrangement These lists might be helpful as an introduction to the total contents of the volumes, but both would be so lengthy that most readers would probably be overcome by ennui before reaching the end For this reason it is probably enough to say, first, that leading men of science and other scholars were consulted when the general plan of the encyclopædia was being drawn up and that the advisory editors in biology were Profs W H. Pearsall (botany) and Munro Fox (zoology) of the University of London, they were ably assisted by Prof F J Lewis, formerly professor of botany at Fouad I University, Cairo (botany), and Sir Norman Kinnear, until recently director of the British Museum (Natural History) (zoology), secondly, that in the first of the fifteen volumes there are at least twenty-seven biological contributors, most of whom have names known all over the world, and, thirdly, that the managing editor has wisely decided that though the majority of the contributors to an encyclopædia primarily written for British readers should be British, contributions on particular topics should be included from recognized authorities, professional or amateur, in any part of the world whether Britain, Baghdad or Brazil

A superficial idea of the range and quality of the contributions may be obtained by random gleaning in the different volumes In volume one, for example, the first biological contribution describes existing aard-varks The third gives a short account of Abbotsbury, the Dorset home of the famous swannery Later follows a good account of abyssal fauna with appropriate line drawings, descriptions of the Acanthocephala and Acanthodii are similarly illustrated When the Algæ are considered, however—the contributor being, not unexpectedly, Prof F E Fritsch—besides three useful series of line drawings there is an accompanying plate in colour with reproductions of original paintings of seaweeds by Shirley Townend A later article on artificial insemination in human beings shows the restraint with which this and other controversial subjects are treated throughout the Encyclopædia.

In the "B's" a full account of bananas, including details of cultivation, harvesting, transport and ripening, pests and diseases, is surprisingly followed by a cavalier treatment of buttercups The section dealing with the behaviour of animals, on the other hand, includes separate contributions by two specialists A lengthy and well-written account of biophysics leaves one wondering why no separate description of biochemistry is given , the omission of an article on biological control is also puzzling The section on birds leaves little to be desired and, good as is the text, will be chiefly remembered by the plate which reproduces E A R Ennion's paintings of uncommon birds in flight

In the "C's" an article on cabbages will satisfy both the botanist and the gardener , the former may later be perturbed to find that Canada balsam is not included He may also wonder why a long and interesting contribution on bulbs is not supported by a reference to corms The zoologist will welcome a plate containing some original line drawings of crustaceans by F Pattisson, and another, in colour, with reproductions of paintings by D Fitchew, to illustrate an admirable article on colour in animals which not only deals with the general principles of adaptive coloration but also with the chemical and physical nature of colours and with colour change

Under letter "D" a concise account of digestion is followed by an interesting and well-illustrated contribution on the dinosaur A long article on ducks is to be expected in a British encyclopædia, as is the one on dogs , why dogs merit many illustrations and ducks none is not clear

So, letter by letter, one could continue to describe the biological contributions in an encyclopædia which, despite minor criticisms, is a joy to examine A detailed description of the evolution and antiquity of man, for example, is a feature of the "M's" , this makes the absence of reference to the growth of speech under the "S's" rather surprising Among the more common letters of the alphabet is a simple account of vestigial organs and a detailed description of vitamins, including the manner in which the latter are prepared industrially , an interesting biography of Alfred Russel Wallace , a long description of water relations in plants, which may not make easy reading for non-botanists , the surprising omission of reference to yolk and yeast , a friendly and intimate picture of zoos, and, finally, a series of articles on the science of zoology which should satisfy the most pertinacious inquiries of the curious layman

Taking the fifteen volumes as a whole, the number and worth of the biological contributions make impressive reading which should meet the most exacting demands Even though particular items are unexpectedly missing in some places, in general there are likely to be few students of biology who will not warmly welcome the appearance of this new "Chambers's Encyclopædia", in which the amount of space to be devoted to each topic has been carefully and, usually, correctly assessed Besides the ease with which they will find important and fundamental contributions to their own special studies, casual scanning of the pages will provide biological students with a wealth of knowledge in related subjects which they will occasionally need to consult and frequently want to read for their own intrinsic interest.

T H Hawkins

A MILESTONE IN CHEMOTHERAPY

Streptomycin

Nature and Practical Applications Edited by Dr Selman A Waksman Pp xi+618 (London Baillière, Tindall and Cox, 1949) 76*s* 6*d* net

STREPTOMYCIN will go down in the history of chemotherapy as the first proved effective chemotherapeutic agent for the treatment of human tuberculosis, and the earliest really effective one for the treatment of infections due to Gram-negative bacteria Its discovery also directed attention to the Actinomycetes as a fruitful source of valuable antibiotics, and a source from which further outstanding examples have been isolated during the past two or three years Whether streptomycin itself is assured of a lasting place in therapeutics is, however, quite another matter It is not free from toxicity, and its use involves a calculated risk to the patient, while the facility with which many pathogenic organisms acquire permanent resistance to streptomycin is without precedent in chemotherapy These are very definite shortcomings of streptomycin and prompt one to reflect that in the face of competition from better drugs it may yet share the fate of sulphapyridine, not so long ago the outstanding drug of the times and already the outcast of the pharmacopœia

The isolation of streptomycin was first announced in January 1944, and production of significant quantities began in August 1946, about 1,000 kgm being produced in that year Although the preface opens with the tendentious statement that "probably no other drug in the history of medical science has had such a phenomenal rise as streptomycin", it must be remembered that the problems involved in the production of penicillin by the deep-culture method had been brilliantly solved, and the basic technical knowledge and plant were already available when streptomycin reached the stage calling for large-scale production Intensive clinical trials followed, and the present volume reviews the widely scattered literature on streptomycin The book is divided into four sections—covering microbiological and chemical aspects, antibacterial and pharmacological aspects, clinical applications and miscellaneous uses of streptomycin—and is the work of fifty-eight authors, all of whom have made notable contributions to the researches reviewed

In the first section, consisting of six chapters, a historical introduction is followed by two chapters dealing with the nature, nutrition, strain selection and strain specificity of *Streptomyces griseus* Two chapters review the production, isolation and chemistry of streptomycin, and a chapter is devoted to microbiological and chemical methods of assay

The second section, consisting of nine chapters, deals with the antibacterial activity of streptomycin *in vitro* and *in vivo*, its use in experimental tuberculosis, and streptomycin-resistance in tubercle bacilli Absorption, distribution and excretion, together with the general pharmacology of streptomycin, are discussed in two chapters, and it is made clear that, while it is still a problem, the neurotoxicity of the drug is much less evident with the purer preparations now available Although it is not the only chemotherapeutic agent upon which once-sensitive micro-organisms can acquire dependence, this striking phenomenon is but another of the peculiarities of streptomycin in respect to the ease with which it can be acquired Here indeed is a fascinating problem in bacterial genetics, and the interesting observation has been made that concentrations of streptomycin in broth above which streptomycin-dependent variants multiply is the same or very close to those above which growth of the sensitive parent strain is inhibited. It may also be added that streptomycin-dependent organisms cannot produce progressive disease in animals in the absence of streptomycin.

Clinical 'uses' of streptomycin are described in the third section of twenty-six chapters, occupying about half the book. Many of these so-called uses scarcely justify the term, and their inclusion makes this section of the volume very uneven. On the other hand, the chapter dealing with streptomycin in the treatment of human tuberculosis is of outstanding merit as an example of objective appraisal both of the difficulties inherent in the chemotherapy of tuberculosis and of the role of streptomycin in the treatment of various forms of the disease. The concluding section of five chapters deals mainly with applications of streptomycin in veterinary medicine.

The book contains a wealth of knowledge on streptomycin, established despite the haste of its gathering, and will interest a wide range of readers drawn from the fields of microbiology, chemotherapy and clinical medicine, and not merely those with a parochial interest in streptomycin.

J. WALKER

TEN YEARS OF CHROMATOGRAPHY

Progress in Chromatography, 1938–1947

By Prof. L. Zechmeister. Pp. xviii+368. (London: Chapman and Hall, Ltd., 1950.) 45s. net.

DURING the decade 1938–47 a number of important advances were made in chromatographic methods, while the original Tswett form has continued to be widely used and has proved to be of the utmost importance in many separations, steroids and vitamins being notable examples. The previous decade had seen the establishment of the older chromatographic methods, and the treatise "Principles and Practice of Chromatography" by Zechmeister and Cholnoky has been accepted as the most authoritative work on the subject. However, its successor, namely, this new book by Prof. L. Zechmeister, has not maintained this high standard. Some two-thirds of the book consists of highly condensed practical details of many separations, the treatment taking the form of abstracts rather than giving a critical evaluation which one expects from a work of this kind. The author has been very thorough and little has escaped him—more than two thousand substances are covered—but it is difficult to find one's way in such a mass of detail. There are a number of tables summarizing data for various important groups. This is a valuable feature and could well have been extended to replace much of the descriptive matter. It is difficult to see why Table 16 dealing with the steroids could not have been arranged like the other tables. In its present form, covering six pages of small print, it is very confusing and is scarcely a table at all.

The new methods are discussed in a short general section which also contains some brief historical notes of interest and a good discussion of stereoisomer separation. In general, the treatment here has been scrappy. The theory underlying adsorption on ion-exchange resins is dismissed in a few sentences, while the theory of frontal analysis and displacement development has not received the attention it deserves, and in the case of frontal analysis is presented in a confusing way (cf. Claesson[1]). The key diagram (Fig. 6) of the two-dimensional chromatogram has been carelessly drawn; the cysteic acid spot is not shown, while other amino-acids, for example, glutamic acid, are not in their correct relative positions. The discussion on adsorbents in Chapter 2 is almost wholly confined to alumina, but there are now so many other adsorbents in common use that there is surely justification for their inclusion.

The bibliography occupies thirty-seven pages as compared with only fourteen in the earlier work. This gives an idea of the rapid progress during 1938–47; but there is little to recommend the collection *en bloc* of all these references at the end of the book.

The reader new to the subject will gain little understanding of the significance of the newer methods, of how, for example, they are now being so widely used in structural studies of proteins, polysaccharides and nucleic acids. This is not entirely the fault of the author, but rather due to delays in publication. No book on a rapidly expanding subject can be expected to have all the latest information; but when publication takes as long as three years, it is inevitable that some of the subject-matter has become obsolete, and that some outstanding developments are not included. As a source of reference this book fulfils a useful purpose; but in order to get an up-to-date picture, the reader will have to supplement the book by reference to various review articles and symposia which have been published during the past two years, such as those on chromatographic analysis[1,2], partition chromatography[3–5] and paper chromatography[6,7].

R. CONSDEN

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[7] Consden, R., *Nature*, 162, 180 (1948).

DIRECTORY OF INTERNATIONAL SCIENTIFIC ORGANIZATIONS

Directory of International Scientific Organizations

Pp. 224. (Paris: Unesco; London: H.M. Stationery Office, 1950.) 1 dollar; 6s.; 300 fr.

ONE of the reassuring aspects of contemporary world affairs is the way in which scientific and technical matters can be, and are, debated on an international level in an objective manner with little or none of that partisan rancour that so often mars discussion in politics, economics, sociology, and even the arts and culture in general. Such international liaison is best obtained through the medium of an organized body and scientific workers can take pride in knowing that there are few specialist fields of science which are not at present covered by an international organization. In fact, now that such bodies number about two hundred, it has become necessary for the United Nations Educational, Scientific and Cultural Organization to publish a "Directory of International Scientific Organizations".

The volume is divided into three parts "Basic Sciences", "Applied Sciences" and "Miscellaneous"; the second of these is further sub-divided into agricultural, engineering and medical sciences. Within each division the organizations are listed alphabetically, those limited to a particular geographical area being placed at the end of the appropriate part or section under the heading "Regional". Details pertaining to the organizations are based on a questionnaire sent out to each, asking for information on the following sixteen points: official name, address, nature, aims, governing bodies and officers, membership, commissions, facilities, finances, meetings, voting, publications, relations with other international organizations, short history, bibliography and comments. With regard to 'nature', an organization may be inter-governmental, non-governmental or semi-governmental; the first includes all those established through an inter-governmental agreement or diplomatic convention, and the last those which, though they include governments among their members, were not created by an inter-governmental agreement. An adequate subject index completes the work.

A final minor, but by no means unimportant, point may be mentioned. Why do some of these international bodies inflict us with the all-too-common habit of an uncouth collection of initial capital letters (sometimes making a pronounceable word, a practice which is even more uncouth) as an abbreviation of their full title? Most of us take in our stride FAO, WHO and UNO (though to the French-speaking world it is ONU), but how many can recognize, say, III, URSI or (shades of refrigeration) ICES? The easiest way to decipher these is to glance rapidly down the six pages of contents of the Directory where the abbreviations are put in brackets after the full name of the entry. In all fairness, it must be stated that less than half the organizations are encumbered with one of these monstrous alphabetical arrays. As an aid to such identification alone, this Directory should prove very useful, and as a general work of reference it can be highly recommended.

EARLY SCIENCE AT HARVARD

Some Early Tools of American Science

An Account of the Early Scientific Instruments and Mineralogical and Biological Collections in Harvard University. By I. Bernard Cohen. Pp. xxi+201+32 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1950.) 38s. net.

An increasing awareness of the far-reaching effects of science on human civilization has led to a desire to know something of the origins of science. During the past few years the British Society for the History of Science has been formed, and the Department of the History and Philosophy of Science in the University of London has increased its activities. At Oxford and Cambridge the University authorities are taking added interest in their Museums for the History of Science. Nevertheless, at the sixth International Congress for the History of Science, held at Amsterdam last August, it was frequently stressed that there is a dearth of teachers of the subject.

The activity in Great Britain is matched by similar developments in the United States, and Dr. Bernard Cohen, professor of general education and of the history of science in Harvard University, is one of the leading investigators in the United States. This present book, one of several to his credit, has been written around the catalogue of the early scientific instruments placed on exhibition at Harvard in February 1949. Searching through the manuscripts and contemporary records in the college archives to find something about these instruments, Prof. Cohen extracted and recorded in his book all information bearing on the early scientific work at Harvard, so that it is possible to form a tolerably clear picture of the state of science there in the eighteenth and early nineteenth centuries. The difficulties under which the Hollis professors at Harvard worked are clearly discernible. Their instruments and apparatus had to be purchased and, if necessary, repaired in England; and the Atlantic crossing, in those days under sail, took at least two months for the double journey. Much of the purchasing was done by helpful agents or friends, and, as communication was slow, it had to be left to them to select what apparatus they thought might be of use and to consign it to Harvard. The products were thus obtained of the major British instrument makers: Edward Nairne, J. Gilbert, Benjamin Martin, George Adams and W. and S. Jones.

Prof. Cohen is a partisan whose concern it is to establish the pre-eminence of Harvard science and to refute Barrett Wendell's statement that the University had not during the eighteenth century attempted to acquire and publish fresh knowledge; but when part of the evidence for original work cited by Dr. Cohen is a paper by Prof. Samuel Williams on "a very uncommon Darkness in the States of New-England, May 19, 1780", conviction is scarcely carried.

Reading between the lines, we get the impression that the apparatus was not extensively used. The lecture syllabuses which Prof. Cohen quotes at length refer mainly to astronomy and mathematics. These were old-established subjects, which had been taught and studied since classical times and should be distinguished from the newer natural, or experimental, philosophy which was being developed in Europe at the time and was the true forerunner of present-day science. It seems clear that those who received their apparatus unselected, by the crateful, would not have the same enthusiasm for it as those in Europe who were actually devising it and instructing the makers as to its design; and it is possible that much of it remained untouched in the cupboards for long periods.

If we do not agree with the author in his estimate of the worth of the early science at Harvard, we are nevertheless grateful to him for having so carefully collected all the evidence and having presented it in a readable and well-documented form. Besides the chapters dealing with the instruments, there is a chapter on the chemistry teaching, and another on biology and mineralogy. The catalogues and lists of scientific apparatus which form the appendixes of the book (forty-four pages of text and twenty-four pages of illustrations) are extremely useful for those interested in early scientific instruments. It is a pleasing feature that there are photographs of all the forty-six objects described in the catalogue of the 1949 exhibition, and it was a happy idea to illustrate an inventory of apparatus made in 1738 by reproductions of the plates from a book of the period.

H. R. Calvert

Introduction to the Theory of Probability and Statistics

By Prof Niels Arley and Prof K Rander Buch (Applied Mathematics Series) Pp xi+236 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1950) 32*s* net

THIS translation of the third edition of the Danish text can be recommended as a useful and lucid introduction to the elementary mathematical theory of probability for the theoretical physicist For those who wish to handle experimental observations, however, it provides a less complete account , for it touches but lightly upon regression analysis, sampling, estimation theory and significance tests, and omits the analysis of variance and the design of experiments The reader is assumed to have an elementary knowledge of calculus, while a short appendix caters for such matrix algebra as is needed in the later chapters

The first three chapters lay out the foundations of the theory of probability and are outstanding for the perspective in which they place the subject Chapter 4 deals with random variables and stochastic processes Chapters 5 and 6 concern means, moments and characteristic functions Chapter 7 discusses the normal distribution, and the χ^2-, t- and F-distributions Chapter 8 outlines some limit theorems, including the central limit theorem Chapters 9 and 10 consider the practical application of the theory, especially the fitting of distributions to observations, but with only a brief discussion on estimation Chapter 11 deals with the theory of errors, and mentions tolerance limits and fiducial limits without going into the difficulties that arise in interpreting such concepts. The twelfth and last chapter is on least-squares adjustments

The book is well printed and misstatements and misprints are rare page 64 wins the prize for the jolliest misprint with "piecewife continuity"

J M HAMMERSLEY

Chemical Engineering Plant Design

By Dr Frank C Vilbrandt (McGraw-Hill Chemical Engineering Series) Third edition Pp x+608 (New York and London McGraw-Hill Book Co , Inc , 1949) 51*s*.

FOR the benefit of British readers unfamiliar with the earlier editions of this work, it should be explained that 'plant', in the United States, does not refer to single items such as heat exchangers or centrifugals for which the term 'equipment' is used, and consequently this book refers only to the design, construction and location of a complete plant for conducting specified operations General matter is contained in chapters headed foundations, drainage, piping installation, pumps and pumping, the building, power and power transmission, all of which abound in useful information Sixty-three pages are devoted to a very full discussion of the construction and use of flow diagrams, and forty to the development of the design As regards equipment, designers of plant are advised very wisely to make use of standard equipment whenever possible, and a long chapter gives a comprehensive survey of most of the main types of equipment, their relative merits for different applications and their performance data

The British nation has been frequently accused of failing to develop commercially its scientific ideas Chemical engineers are well aware that one of the main bottlenecks in this process is the difficulty of obtaining even approximate costs for the equipment they may require and its operation Following an appeal for data of this type in the United States, many papers were published, and much of the information given is reproduced in the 130-page chapter on preconstruction cost estimating, which is thoroughly up to date and perhaps the best in the book Its contents are of great value even to British chemical engineers Is it too much to hope that something similar, with costs in Great Britain, will one day be available ?

H E WATSON

The Mathematical Theory of Communication

By Claude E Shannon and Warren Weaver Pp v+117 (Urbana, Ill University of Illinois Press, 1949) 2 50 dollars

THE first ninety pages of this small book contain in highly concentrated form a part of the contribution which Dr Claude E Shannon, of the Bell Telephone Laboratory, New York, has made during the past few years to the theory of communication The remaining pages are devoted to a descriptive treatment of the subject by Dr Warren Weaver, and most readers will find it advantageous, if not necessary, to give this section prior attention

In brief, Dr Shannon establishes a means of measuring the information content of messages and discusses how the statistical structure of language may be changed so as to increase the information content per symbol He then deals systematically with the encoding process by which messages are changed into suitable signals for electrical transmission, with assessment of the capacity of a channel for transmitting these signals and with the effect of noise on this capacity

The book is written from the point of view of the electrical communication engineer, but, as revealed in a recent symposium on information theory (see *Nature*, January 6, p 20), its contents have a much wider significance and are likely to exercise an important influence on work in several other branches of science Few will find it easy to read, but many should make the attempt

W J

Smithsonian Institution

United States National Museum Bulletin 50 The Birds of North and Middle America By Herbert Friedmann Part 11 Pp xiii+793 (Washington, D C Government Printing Office, 1950) 4 dollars

THIS Part of Smithsonian Institution Bulletin No 50 deals with the birds of prey, many of which are not easy to identify on account of the different stages of plumage they pass through before becoming fully adult A golden eagle, for example, does not assume the adult plumage until it is from four to four and a half years old , sparrow-hawks, buzzards and others take about half that time A few, however, moult straight from the juvenile plumage to that of the adult In addition, certain species vary much in colour, and in some kinds of buzzard there is a pale, a dark, and a rufous phase of plumage All this adds to the difficulties of identification, but Dr Herbert Friedmann has clearly described all the different sequences of plumage and variation in colour Though the work is restricted to North and Middle America, the author has included in the keys to species some extra-limital forms, which may occur as vagrants This is an innovation which should add much to the usefulness of this valuable work

THE SONIC SCATTERING LAYER IN THE SEA

By A. C. BURD and A. J. LEE
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UNDERWATER sound investigations carried out during the Second World War in the United States revealed the presence in the oceans of extensive deep layers which interfered with the transmissions of an echo sounder. It was assumed that the layer scattered the sound. Hence these layers have come to be known as 'deep scattering layers'. The resultant trace has the appearance of a false bottom, and occurs at depths of 150–450 fathoms.

Dietz[1] and Hersey and Moore[2] have dealt with the deep scattering layers recorded from the Pacific and Western Atlantic Oceans respectively. The layer descends at about first light, and remains during daylight hours at 150–450 fathoms. In the highly transparent tropical water the layer is, in daylight, typically at about 250–350 fathoms, whereas in the less transparent coastal water off California it lies, in daylight, at 150–250 fathoms. At dusk, a rising towards the surface takes place. On the 18-kc. echo sounder recordings, which form the bases of the two papers mentioned above, about the first sixty fathoms are masked by the length of the transmission signal, and as a result the behaviour of the layers in this region is not revealed.

The American workers have discussed the possibility of the layer being caused by physical phenomena, but come to the conclusion that no known physical phenomenon could account for its behaviour. They suggest that the layers are caused by vertically migrating organisms.

Moore[2,4] is of the opinion that the layer consists of Euphausids. He obtained a density of 1–3 per metre[3] in obliquely hauled nets. He considers that a true estimate of the numbers present would be at least ten times this value, owing to the inefficiency of the plankton net in sampling very active organisms. He has also demonstrated a relationship between the depth of the layer and the depth of extrapolated 'iso-illumination' curves, and finds that the diurnal movements may be in some cases limited by temperature gradients. Lyman[3] has suggested that squids are the cause; but Moore does not accept this. Bodon[5], using three different types of net, also finds Euphausids to be the only animals to appear consistently in quantity in the layer; 25 Euphausids per 100 metres was the average density for vertical hauls in the layer. He also suggests that the Pacific saury (*Cololabis saira*), an oceanic plankton-feeding fish, may be a contributory cause of the layer.

Tchernia[6], who has made extensive cruises in the Mediterranean and Red Seas, and in the Pacific, Indian and Antarctic Oceans, regards the layer as a universal phenomenon. In contradiction to the observations of Dietz, he found that the layer was as well developed in the Antarctic regions as in the other areas. Neither the Antarctic Convergence nor the pack ice represented the limits of the extension of the layer. It should be noted, however, that the echo sounders used by Dietz gave an 18-kc. pulse, whereas the WEA 1 used by Tchernia had a frequency of 24.8 kc. The results of the two sounders may not be exactly comparable. Quoting the findings of Bernard, who has shown that the poorest zone of plankton in June off Algiers is, in daylight, between 300 m. and 350 m., Tchernia records that this is the precise depth at which he and Moore[6] have recorded the layer in the same area. Furthermore, in a personal communication he informs us that he has obtained records of layers which do not migrate diurnally and which he does not regard as biological phenomena.

Raitt[7], working with the deep scattering layer, measured the returning signal with an oscillograph and came to certain conclusions with regard to the size of the organisms comprising the layer. He regarded each peak on the oscillogram as the return signal from a single scatterer, and based his calculations on this hypothesis. Although he suggests that the signals received may be the return from 'swarms' of small scatterers, he does not follow up this argument. Hence his conclusions, with regard to the size of the organisms responsible, are to be held in doubt.

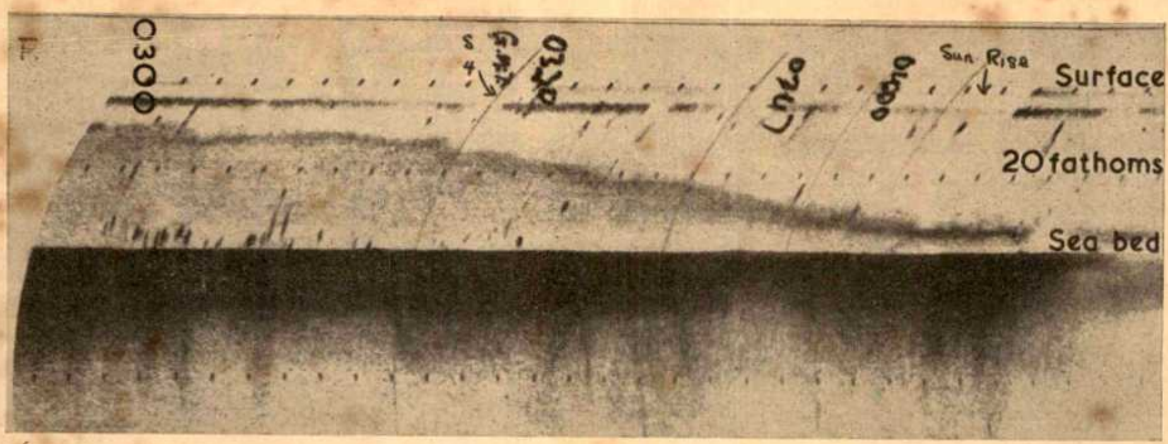
Hitherto, the presence of these layers has only been reported from the very deep water of the oceans and the greater seas. During the past two years, layers of an analogous nature have been detected in the comparatively shallow waters of the English Channel, southern North Sea and the Barents Sea near Bear Island by the echo sounders on research vessels of this Laboratory.

The first of these layers recorded in British coastal waters was found off Robin Hood's Bay in September 1949. The R.V. *Clupea*, while drifting, recorded on a 14-kc. echo sounder a compact layer which was not of very great density, and which rose from a depth of about 45 ft. to about 35 ft. in the hour before sunset. After this the trace was lost, and in a search over the area the layer was not recorded again. It is probable that the organisms had dispersed in the dark.

During the spring and summer of 1950, layers were recorded extensively in the English Channel on the 14-kc. and 30-kc. echo sounders of the R.V. *Sir Lancelot*. One trace extended from the Scillies to east of Start Point, a distance of about seventy miles. A description of the behaviour of the layer recorded during the day and night of June 14–15 may be taken as a typical example.

The layer was first observed lying close to the bottom at 1800 hr. G.M.T. on June 14. The depth of water was 40 fathoms and the top of the layer was recorded at 36 fathoms. The layer rose slowly off the bottom until at 2014 hr. the top edge of it was recorded at 27 fathoms. At sunset, 2027 hr., it had risen to 22 fathoms, and by 2209 hr. it was at 5 fathoms below the surface; after this time it dispersed and could not be detected again until 0100 hr., when it became apparent at 12 fathoms. At 0310 hr. the top of the layer was at 14 fathoms and at 0412 hr. (sunrise) at 33 fathoms (see accompanying illustration). The layer remained about this level, which was close to the bottom, throughout the daylight hours.

During these twenty-four hours of observations, hauls were made with various gears in order to catch the trace makers. The Petersen Young Fish Trawl was the most successful, giving for the first time



Trace of the scattering layer off Lizard Head, June 15, 1950, recorded on a 14-kc. echo sounder of the R.V. *Sir Lancelot*. Migration towards the bottom is shown in daylight. The horizontal distance between dots represents three minutes. The vertical interval is 20 fathoms. Other traces, probably pilchards, can be seen near the bottom on the left and occasionally elsewhere

some definite information on the composition of a layer. A total of eight hauls was made, of which five were in the layer, two above it, and one on the edge of the layer. A depth recorder was used to ascertain the depth at which the trawl had been fishing.

The catches consisted of larval fish, *Calanus*, decapod larvæ, medusæ, *Sagitta* and *Eupagurus* larvæ. Of these organisms the only ones which appeared consistently in similar numbers in each of the hauls in the layer were the fish larvæ. The other organisms showed patchiness, many being caught in one haul and few in another. For example, in one haul of 15 minutes duration, 488 *Eupagurus* larvæ were captured, while in another haul of the same duration only 21 were caught. The nature of the trace was a homogeneous cloud which might not have been producible by these other organisms. The greatest total biomass in the layer was that of the fish larvæ, of which 70 per cent were young pilchards 11·5 mm. long, and about 10 per cent *Crystallogobius* sp., 12·5 mm. long, both of which species possess air bladders, those of the latter measuring about 3 mm. in length.

Very small bubbles of air are known to be excellent scatterers of underwater sound, as a gas has a markedly different density and compressibility from water. Such bubbles have an 'effective diameter' many times that of fish flesh of the same actual diameter. The presence of the air bladders in these fish will therefore increase their scattering surfaces considerably, and because of this they will be the most efficient scatterers of the organisms in the layer.

There were more fish larvæ in the hauls in the layer than in those above it, but when statistical tests were applied the numbers were not quite significantly different. This may be due to a sampling error and also to the small numbers of hauls performed. Despite this, however, the results, when related to the other evidence, suggest that the layers in the Channel were probably caused by large concentrations of young pilchards and other fish larvæ.

In August the appearance of the layer was slightly different. Previously it had appeared as a homogeneous cloud-like trace, but now it had a spottiness superimposed on it. When a Heligoland larva net was hauled through the layer, a number of young pilchards about 5 cm. long was obtained. It is uncommon to catch any young fish in this slowly hauled gear unless they are present in very large quantities. The spotted character of the trace may be related to the increase in the size of some of the pilchards comprising the layer.

During plankton sampling near Flamborough Head in May 1950, a layer was recorded near two plankton stations only. The zooplankton as caught by the Hensen net was more or less evenly distributed over the whole area. This would seem to rule out the zooplankton as being the trace maker on this occasion.

Again, in the southern North Sea in July, when the R.V. *Sir Lancelot* was engaged in trawling experiments, a layer was recorded on the echo sounder when the trawl was being hauled. Thousands of small gobies were found trapped between the knots of the meshes and may have caused the layer in this case.

Early in October 1950, the R.V. *Ernest Holt* was working in the Barents Sea, near Bear Island, where traces were recorded on the echo sounders which did not resemble those known to have been produced by cod. The greatest extent of the trace was about twenty miles. These traces were recorded on both 10-kc. and 14-kc. echo sounders, and on four occasions were seen to descend from near the surface to the bottom, during the 2¾ hours between nautical twilight (sun's centre 12° below the horizon) and sunrise. The depth of water varied between 40 and 95 fathoms. Between 1¼ and 2¾ hours after sunset, that is, during the period between civil twilight (sun's centre 6° below the horizon) and nautical twilight, these traces were observed to ascend from the bottom to near the surface. The rate of descent at sunrise was observed to be quicker when the sky was clear than when it was overcast. Parts of the trace descended at different rates, suggesting that different organisms, which were sensitive to differing light intensities, were present.

In order to catch the organisms, various attempts were made to tow nets in the trace, but without success; other evidence showed the presence of herring, however. The stomach contents of cod caught in the localities where this type of trace was observed showed that these fish had been feeding on young herring 10–12 cm. long, which were also found between the meshes of the trawl. Commercial trawlers reported that herring on the sea surface were washed inboard through the scuppers during the hours of darkness.

It seems reasonable to suppose that the young herring were at least partly responsible for this type of layer. The herring themselves were feeding on

Calanus and Euphausids, and it is not known whether these latter contributed to the trace.

In summarizing the observations on the scattering layers in the sea, we conclude that no generalization is possible as to their cause. However, in the above-mentioned shallow waters there are layers which are: (1) diurnally migrating and analogous in behaviour to some of the deep scattering-layer observations of the American authors; (2) of wide occurrence, being present in the English Channel, southern North Sea, and the Bear Island area; (3) at times very extensive, stretching over 70 miles in the western English Channel and 20 miles at Bear Island; (4) of relatively short existence in comparison with the deep scattering layer; (5) probably caused by young fish 12 mm.–12 cm. in length, their air bladders playing a great part in rendering them more liable to interfere with the transmissions of the echo sounder.

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WINDS AND TURBULENCE IN THE UPPER ATMOSPHERE

IT was at one time thought that winds and mixing of the atmosphere occurred mainly below about 12 km., where the temperature was known to decrease upwards, and that above this level, in the so-called stratosphere where the temperature was thought to be independent of height, the atmosphere was considered to be more or less at rest and stratified in horizontal layers of uniform density. At intervals, observations of self-luminous objects such as meteor trails and luminous night-clouds have suggested that the atmosphere at heights of about 100 km. is turbulent, and even that uniform winds occur there. These observations are infrequent and present such an incomplete picture of the upper-atmospheric motions that meteorologists have not been in a position to try to explain them. Recently, however, several new radio methods have been developed by which the turbulent and wind-like motion of the ionosphere can be investigated, and, since these methods do not depend on the chance occurrence of some self-luminous phenomenon, it appears as though they may soon provide a reliable description of upper-atmospheric motions which meteorologists can then attempt to explain.

With the object of collecting and comparing results of the radio measurements and presenting them in outline to the meteorologists for their consideration, a Geophysical Discussion on "Winds and Turbulence in the Ionosphere" was held at the Royal Astronomical Society on February 23, with Mr. J. A. Ratcliffe (Cavendish Laboratory, Cambridge) in the chair. The radio methods described all depend on the recognition of some irregularity in the ionosphere and then on measurements of the rate at which it moves either in a turbulent irregular way or horizontally with a wind-like motion. The experimental methods differ in their ability to detect and use irregularities of different size and in different regions of the ionosphere.

Dr. W. J. G. Beynon (University College, Swansea) gave a short account of the observations of G. H. Munro[1], who worked in Australia and used ordinary ionospheric sounding equipment at points separated by tens of kilometres. Munro identified certain large-scale phenomena on the P'–f curves and found that they were often approximately repeated, but with a time lag, at the different observing points. He deduced that there were irregularities in the horizontal distribution of ionization in the F-layer with a 'size' of about 400 km. and that they appeared to move with velocities of the order of 100–200 m./sec. The movement was predominantly towards the east; there did not appear to be any regular diurnal change in the direction of movement, but a seasonal variation, with a rather sudden change at the equinoxes, was noticed. Dr. Beynon himself has observed similar movements in the F-layer: during the Second World War[2] when he found that sometimes ionospheric irregularities which appeared to influence the transmission from Zeesen (Berlin) to Slough would also influence waves reflected vertically at Slough some time later; and in more recent experiments made between Swansea and Slough (230 km. distance), when he has found that the direction of motion sometimes changes in the course of one day.

Some experiments of a different nature, which seem to throw light on the same large-scale irregularities in the F-layer, were described by Mr. E. N. Bramley (Radio Research Station, Department of Scientific and Industrial Research). He has measured the direction of arrival of a short train of radio waves reflected from the ionosphere at nearly vertical incidence, and has deduced that the layers of constant ionization are often tilted through angles of a few degrees. Comparison of the observations made at points separated by about 27 km. has led to the conclusion that similar tilts occur at the two places but with a time lag which corresponds to the passage of a disturbance overhead. These disturbances have a size of about 100–500 km. and move with a velocity of about 35–350 m./sec., with a general tendency to move towards the east. Mr. Bramley stressed that observations of this kind lead only to a knowledge of changes in the distribution of the ionization and do not necessarily imply the presence of winds in the atmospheric gases.

Another method of investigating the F-layer was explained by Dr. A. C. B. Lovell (University of Manchester), and also by Mr. Ratcliffe, who described results obtained by Mr. M. Ryle (Cavendish Laboratory, Cambridge). In this method the waves received at the ground from a 'radio star' on wave-lengths of 3·7 m. (Lovell and Ryle) and 6·7 m. (Ryle) are studied. Their amplitude is often found to vary with time in a way analogous to the scintillation of optical stars, and experiments with spaced receivers[3] have shown that these variations are produced by irregularities in the terrestrial ionosphere having lateral dimensions of the order of 5 km. These irregularities are associated with the conditions in the F-layer which produce 'spread-F echoes' on ionospheric sounding equipment. Dr. Lovell thinks that there is some evidence that the ionospheric irregularities are smaller towards the polar regions.

It has been suspected[4,7] for some time that the 'scintillation' of the radio stars is caused by regular movements of the ionospheric irregularities, and recent experiments using spaced receivers have confirmed the presence of steady movements of the irregularities with speeds of the order of 100 m /sec A surprising result, mentioned by Mr Ryle, is that the direction of the wind along the east–west line has, on some occasions, been found to reverse within a time of about thirty minutes

Mr G J Phillips (Cavendish Laboratory, Cambridge) described measurements on the E-region at a height of about 100 km He used the method of S N Mitra[5] in which short trains of radio waves are received, after reflexion from the ionosphere, on three receivers situated close to the transmitter and separated from each other by distances of the order of 100 m From the fading observed at the three receivers, it is possible to deduce that the E-layer has an irregular structure in which the smallest size of irregularity is about 200 m, and that the irregularities move with random turbulent speeds of about 1 m /sec On most occasions the random movement is almost completely masked by a regular wind-like movement with a speed of the order 80 m /sec Measurements of the speed of this wind have been made on three days every month over the past two years, and although there is a considerable amount of irregularity in the behaviour, there also seem to be some regular features—for example, the behaviour in the summer months has been more regular than in winter, and has shown a wind predominantly towards the west by night and towards the east in the midday hours Somewhat similar results have been obtained by workers using the same experimental methods in Washington, D C A harmonic analysis of the results shows a statistically significant semi-diurnal solar tide The horizontal tidal motion found is represented by a vector with a clockwise rotation having a magnitude of 20 ± 10 m /sec and directed towards the east at 0630 hr, but no statistically significant lunar tidal component has been found. There is some evidence to show that the F-layer has a fine structure of the same sort of size as that in the E-layer, and that it moves with similar velocities On some occasions the velocity measured with waves reflected from the E-layer is reversed within half an hour, but it is just possible that this reversal represents phenomena occurring at two different heights

Dr Lovell summarized work done by L A Manning and others[6] in the United States He measured the Doppler effect on waves reflected from meteor trails and deduced that it corresponded to a wind with a velocity of the order of 30 m /sec The height of these trails was known to lie somewhere in the region of 80–100 km Most of the wind-like movements were towards the north-east or to the south, and there were some rather sudden changes of direction which might possibly correspond to different directions at different heights Dr Lovell also mentioned some experiments made by his own colleagues, in which the rapid fading of the echo returned from meteor trails was studied, and from which it was deduced that there were irregular turbulent velocities of about 25 m /sec at levels of about 90 km

Mr Ratcliffe summarized the radio evidence as shown in the accompanying table

Approximate heights	Horizontal size of irregularity	Turbulent velocity	Drift velocity	Worker and remarks
>300 km	5 km	—	100 m /sec	Lovell & Ryle Some reversals within 30 mins (Ryle)
250 km	500 km	—	100 m /sec	Munro, Beynon No diurnal variations Seasonal changes near equinoxes Movement predominantly towards east
250 km	100–500 km	—	35–350 m /sec	Bramley Movement towards east
250 km	$\nless$ 200 m	1 m /sec	80 m /sec	Phillips
100 km	$\nless$ 200 m	1 m /sec	80 m /sec	Phillips Some regularity in diurnal behaviour repeating over 2 years and in America Some rapid reversals
90 km	Ionized meteor trails	25 m /sec	—	Lovell
90 km	Ionized meteor trails	—	30 m /sec	Manning Reversals of velocity possibly related to small changes of height

Discussing these results from the point of view of a meteorologist, Prof P A Sheppard (Imperial College of Science and Technology, London) emphasized that temperature difference provides the most probable source of the energy required for the wind-like motions If geostrophic winds with a velocity of about 50 m /sec in an east–west direction were to be produced by a horizontal temperature gradient in a layer of thickness 10 km, this gradient would have to be of the order of 1° C per 100 km in a north–south direction In a changing pressure field it is also possible to have an isallobaric wind which flows from a place where the rate of change of pressure is high to a place where it is low If winds of velocity 50 m /sec were produced in this way in a layer of thickness 10 km, there would have to be a temperature gradient changing at the rate of 4° C per hour per 1,000 km Even near sunrise a differential heating of this magnitude is unlikely It can be shown that Eulerian winds, flowing from regions of hot air to regions of cold air, would require a diurnal temperature variation of 10° C and would be accompanied by a marked seasonal variation of wind Prof Sheppard stressed that it is difficult to explain the reversals of wind which have been reported, and he suggested that the most likely explanation is that there is a quasi-geostrophic flow in different directions at different levels and that the radio observations do not always apply to the same level

In the free discussion which followed, Mr Ryle pointed out that even if the observations made with waves reflected from the ionosphere could be explained in terms of reflexions from different levels at different times, this is not a possible explanation of the reversals of velocity deduced from observations of radio stars, since in that case the radiation has passed through the whole of the ionosphere Other speakers stressed that, although the radio observations detect changes in the electron density, they do not necessarily imply the bodily movement of the atmosphere, and in this connexion Dr R E Scorer doubted whether there is any mechanism which might reasonably be expected to produce a wave-like disturbance in the ionosphere such as that suggested by D. F. Martyn[8].

The meeting provided an excellent opportunity for the bringing together of workers in different branches of this subject, and the Royal Astronomical Society is to be congratulated on choosing such a live subject for discussion. The two most important points which emerged from the discussion were: first, because the wind may change in an important way with height, it is essential to measure the height accurately; and secondly, horizontal movements of irregularities of electron density do not necessarily imply bodily movements of the air.

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PLANT CHROMOSOME-RACES AND THEIR ECOLOGY IN GREAT BRITAIN

By Dr. G. HASKELL

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SINCE the "Merton Catalogue"[1] appeared, botanists have had in their hands a list of the chromosome numbers of British flowering plants. It provides a starting point for studying the relations between cytology and various aspects of the flora, such as taxonomic problems, geographical distribution and ecology.

Species may occur with more than one chromosome number, having either a few chromosomes more or less than the normal (aneuploid series), or the numbers are in multiples of each other (polyploid series). Now Darlington[2] has pointed out that sometimes polyploids occurring within the species are indistinguishable from one another except on the basis of distribution, while others may show size differences of a general character. Therefore, if one considers those species in the British flora containing a polyploid series which taxonomists have not assessed as separate species on morphological grounds, such chromosome-races, as they can be termed, may yield information on the effect of chromosome doubling in relation to plant ecology.

Chromosome-races can consist of autopolyploids which may have originated from relatively homozygous diploids or from hybrids between varieties or subspecies of a diploid species[3]. Valentine[4] has discussed the classification and nomenclature of different kinds of polyploid series. Sometimes, as in *Valeriana*, individual chromosome-races within the species recognized cytologically can also be identified by pollen size and stomatal index, which increase with rise in chromosome number. Some of the higher chromosomal types within the species have later flowering. Recently, cytologists have taken precautions to record the habitats of the plant material which they examine, whereas earlier records gave no indication of these.

Some examples can be given which show that there is a relation between chromosome-races and the ecology of the species. For example, Hancock[5] found that the three chromosome-races of marsh bedstraw (*Galium palustre*) occupied different habitats. Diploids ($2n = 24$) in Oxford occurred in damp places which dried out in summer. Tetraploids ($2n = 48$) in Devon occupied intermediate habitats, often being submerged in winter and in soil remaining damp in summer. The octoploids ($2n = 96$) in Oxford lived in permanently damp zones and reproduced vegetatively by creeping shoots and roots at the nodes.

In Europe the common whitlow-grass (*Erophila verna*) was found by Winge[6] to consist of several chromosomal types, with a relation between chromosome number and external form. He divided the collective species into four eco-species, two of which occurred in Britain. These are *E. duplex* ($2n = 30$ to 40), which prefers pastures, gravel-pits and roadsides and is so far recorded only in England, and *E. quadruplex* ($2n = 52$ to 64), which Winge found only in Scotland, growing in low-lying grassland and bogs. It is a much larger plant and perhaps better fitted in competition for light with other species in denser plant associations. In general in *Erophila*, higher chromosome numbers go with larger plants, but the higher chromosome types are handicapped by later flowering and inferior seed setting. No doubt further sampling of the *Erophila* complex in Britain will reveal information as to whether (as seems possible) chromosome number in this species gradually increases northwards.

Lovkvist[7] in southern Sweden found that there is both a polyploid and an aneuploid series within the species of lady's smock (*Cardamine pratensis*), as in *Erophila*. Plants with different chromosome numbers occur together in meadows, but there is a regional distribution. Plants with lowest numbers ($2n = 30$) occur in the higher drier parts, while lower parts contain the intermediate races ($2n = 56$ to 68). The highest chromosome-races ($2n = 72$ and 76) are near or in water. This suggests that here there is a direct relation between chromosome number and water content of soil among members of the same species in local competition. A plant from the light soil of the former John Innes site at Merton was $2n = 32$ [8], while plants from three rather wet situations near Cambridge[9] were $2n = 56$, indicating that a similar situation probably holds true in Great Britain.

There are two British chromosome-races of parsley piert (*Aphanes arvensis*) according to Walters[10]. The diploid (*A. arvensis* s. str. $2n = 16$) is a sexual form indifferent to soil acidity and occurring in forty-three vice-counties[11], while the hexaploid, now known as *A. microcarpa* ($2n = 48$), is apomictic and restricted to acid soils; it occurs in thirty-seven vice-counties. Lesser celandine (*Ranunculus ficaria*) occurs in all vice-counties and comprises four chromosome-races, including a sexual diploid ($2n = 16$) producing viable seeds and lacking tubers in the axils of stem leaves, and a tetraploid (var. *bulbifera* $2n = 32$) with these tubers. It rarely has good seed, and reproduces entirely vegetatively by root tubers. According to Turrill[12] these two races probably have an unequal range in Britain: both occur in the counties of Middlesex, Surrey and Buckinghamshire, but only the diploids have been found in parts of Devon and Somerset. Further records of such chromosome-races would be welcome.

Darlington and Mather[13] have re-emphasized that simple chromosome doubling produces both a genetic change and simultaneously establishes a discontinuity by creating a new form which will not cross with the old They point out that a single colonizing polyploid individual can produce variation impossible to a solitary diploid, and so when there are sudden opportunities for colonization to occur, as after an ice-age, the new polyploid can step in and quickly acquire a large range from which its diploid parent is excluded Evidence for this is provided by the two chromosome-races of valerian (*Valeriana officinalis*) studied by Skalinska[14] The tetraploids ($2n = 28$) are limited to southern England south of a line from the Bristol Channel to the Wash, and roughly corresponding to the 62° F July isotherm, while the octoploids ($2n = 56$) extend as far north as West Inverness Within their common area, for example, Gloucestershire, the two chromosome-races are ecologically separated, tetraploids being confined to dry, limy or chalky habitats in hilly regions, while octoploids grow at lower altitudes in moist soil, along river sides and on ditch banks Yet farther north, where octoploids alone occur and have spread after the ice retreated, there are variants which grow in both dry and wet places In this instance an *old* tetraploid has behaved as a relative diploid

There are three British chromosome-races of watercress (*Nasturtium officinale*), the species occurring in all vice-counties[11] Manton[15] has separated them on morphological as well as cytological grounds The diploid (*N officinale* s str, $2n = 32$) is an annual with bright green leaves while the tetraploid is the perennial winter watercress (*N microphyllum*, $2n = 64$), recognized by its purplish-brown leaves in cold weather Recent but still incomplete records of their distribution[16] suggest that the diploid tends to occur more in the western part of Britain while the tetraploid occurs more to the east, both species overlap in midland counties Perhaps the diploid occurs in areas with higher mean annual rainfall than the tetraploids On the other hand, the same records for the sterile triploid show an irregular but wider range of distribution from east to west, it may be absent where both parents occur and be present where both are absent Field studies in Oxford have, however, failed to show ecological preferences between diploids and tetraploids[12]

Many other chromosome-races require investigation For example, in Britain there are two closely related *Arum* species *A neglectum* ($2n = 63$) is a nonaploid confined to the south coast of England, while the common cuckoo-pint (*A maculatum*, $2n = 56$ and 84) occurs throughout Britain with a sharp delimitation at latitude 56° N Salisbury[17] has pointed out that probably the different species distribution is due to differences in times of leaf emergence But we do not as yet know what kinds of distribution the two chromosome-races of *A maculatum* have in relation to each other

Investigations have also been made into the cyto-ecological relations of closely related species within a genus, members of which can still sometimes hybridize Thus, Fitzpatrick[18] has established a relation between ploidy and normal habitats among British meadow-grasses (*Glyceria* spp), all of which are morphologically distinct The diploid species (*G declinata*, $2n = 20$) is most drought-tolerant, living in dried-up ponds and cart ruts, while the two tetraploid species (*G plicata* and *G fluitans*, $2n = 40$) prefer wetter habitats such as ditches and stream edges The hexaploid species, *G maxima* ($2n = 60$), is a typical constituent of reed swamps[12]

The relation between chromosome-races and ecology can also be observed in Pteridophyta For example, Manton[19] has found that in the common polyploidy fern (*Polypodium vulgare*) the diploid ($2n = 74$) usually occurs on limestone habitats in south-west England and in Yorkshire This race, known as the variety *serratum*, has its dormant season in summer, putting out new fertile fronds in August or September, while the tetraploid ($2n = 148$) is earlier, producing new leaves in May and June The hexaploid ($2n = 222$) is a large plant with thicker leaves and has an extended season from summer to autumn, it prefers moister climatic conditions, and is the commonest type in Ireland, Wales and south-west England and the only race on Jersey

Where there are ecological differences between chromosome-races within a species the general trend becomes clear Within the species, lower chromosome multiples prefer drier habitats and there is a progressive trend through intermediates to the highest polyploids, which prefer moist or wet habitats Aneuploidy is not so important in this respect as polyploidy It remains to be determined how this has come about, the actual physiological relationships involved, and whether the phenomenon is related to a change-over from sexual to apomictic or vegetative methods of reproduction which so often accompany higher polyploidy[2]

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OBITUARIES

Prof Cyril Batho

We regret to record the death of Prof C Batho, which occurred at his home in Birmingham on March 23, after an illness which had lasted some months Prof Batho retired only last year from the Beale chair of civil engineering in the University of Birmingham, and was afterwards accorded the title of emeritus professor

Born in Liverpool on June 21, 1885, Dr Batho was educated at Liverpool College and at the University of Liverpool, where he later spent some time in postgraduate research He was appointed to a lectureship in civil engineering at McGill University in 1908 and thereafter spent two years in postgraduate study at Berlin and Charlottenburg, returning to McGill University in 1911 as assistant professor In addition to his work at the University, he acted for a period as an assistant design engineer on the Quebec Bridge

Following the outbreak of the First World War in 1914, Prof Batho became research officer to the Canadian Machine Gun Corps and, later, served as senior technical assistant at the Royal Aircraft Establishment, Farnborough After spending a short time as lecturer at Trinity College, Cambridge, he returned to McGill University in 1919 as associate professor of applied mechanics and hydraulics In 1924 he was appointed to the chair of civil engineering in the University of Birmingham, where he remained until his retirement in 1950

Prof Batho was responsible for a considerable amount of research dealing with reinforced concrete and various aspects of structural engineering, his main interest being in statically indeterminate structures and in riveted and other connexions He was chairman of the Midland Association of Civil Engineers during 1932–34 and a member of the Steel Structures Research Committee from 1929 until 1936

A bachelor and of a retiring disposition, Prof Batho was a man of wide cultural interests His devotion to music and the arts led him, in the years gone by, to pay numerous visits to Continental centres

Prof Giovanni Giorgi

On August 19 of last year the scientific world suffered a great loss by the accidental death, through drowning, of Prof Giovanni Giorgi, of the University of Rome, widely known as the proposer and champion of the M K S system of electrical units which bears his name

Prof Giorgi was born at Lucca on November 27, 1871, took his degree in engineering at Rome in 1893 and immediately devoted himself to the study of theoretical physics and mechanics He explained his scheme of units in 1901 in a paper published in *Atti della Associazione Elettrotecnica Italiana*, and submitted three years later to the St Louis Congress of the International Electrotechnical Commission The Giorgi system was officially adopted by the Commission in 1935 it is an extension of the practical system (amperes, volts, henries, farads, etc) to include electric and magnetic fields In Giorgi's words, "this will result in a great simplification of all practical calculations and of the learning of electrical theory in the schools A great deal of waste of time and intellectual fatigue will be saved "

In 1903 Prof Giorgi published an important paper on methods of studying and representing sinusoidal alternating currents, and he followed this by several papers on electrical transients He gave a precise theoretical basis to Heaviside's operational calculus

Giorgi was the author of more than three hundred and fifty papers on physical and mathematical subjects All his writings are characterized by clarity of ideas, simplicity of exposition and elegance of expression

We regret to announce the following deaths

Dr E E Day, formerly president of Cornell University, a distinguished economist and statistician, on March 23, aged sixty-seven

Mr G E. Pearson, formerly chairman and governing director of the Wellcome Foundation, Ltd , on March 29 aged eighty-two

NEWS and VIEWS

Mathematics at the Queen's University, Belfast : Prof. T. G Room, F R S

Prof T G Room, of the University of Sydney, who has been appointed to the chair of pure mathematics at the Queen's University, Belfast, was educated at Alleyn's School and at St John's College, Cambridge He held an assistant lectureship in mathematics at the University of Liverpool during 1925–29, and was elected to a fellowship at St John's College, Cambridge, in 1927 From 1929 he was a University lecturer in mathematics at Cambridge, until he was appointed to the chair of mathematics at Sydney in 1935 At Cambridge his geometrical powers developed under the guidance of Prof H F Baker, and he soon began to make important contributions to the subject Attracted by the synthetic methods of Reye, and interested in the incidence properties of geometrical configurations, he set out to discover generalizations, in higher space, of theorems such as that of the double-six of lines in the solid, and of the set of five associated lines in a four-fold In this connexion he was naturally led to investigate the properties of projectively generated manifolds in higher space In 1939 he published a classical treatise on the "Geometry of Determinantal Loci", giving a systematic account of the subject, of basic importance for further advances The projective properties of these loci are established by a powerful use of synthetic methods, together with simple matrix algebra This branch of geometry is by no means exhausted, and Prof Room is still extending our knowledge in this field Prof Room was elected to the Royal Society in 1941

Civil Engineering at Melbourne : Dr A J Francis

Dr A. J Francis, who has been appointed to the chair of civil engineering in the University of Melbourne, is a graduate of the University of Birmingham, having taken a first-class honours degree in civil engineering in 1934 and afterwards the M Sc and Ph D degrees of that University After graduation, Dr Francis was appointed assistant engineer to the Worcestershire County Council and later joined the staff of John Mowlem and Co During the last years of the Second World War he served with the Ministry of Home Security and the Admiralty At the conclusion of the War he was appointed a lecturer in the Department of Civil Engineering in the University of Birmingham, a position which he held until his appointment to the Melbourne chair this year Dr Francis has specialized in structural research and has published a number of papers on the structural analysis of reinforced concrete, steel and light-alloy structures He is married, with three sons, and takes a keen practical interest in music

Physics Subdivision of the Atomic Energy Project, Canada Dr. B W Sargent, M B E

Dr. B W Sargent has been appointed assistant director in charge of the Physics Subdivision of the Atomic Energy Project, Chalk River, Canada, in succession to Dr W H Watson, who last year was appointed head of the Physics Department, University of Toronto Dr Sargent has been associated with the Atomic Energy Project since its inception, and in 1945 worked on the heavy-water reactor pile, the first to be built in Canada Since then, he has been in charge of the Nuclear Physics Research Branch After graduating from Queen's University, Ontario, Dr Sargent went to the Cavendish Laboratory, Cambridge, and was awarded his Ph D in 1932 for work on beta-rays emitted by radium and similar substances, in the course of which he discovered an important relation now known as "Sargent's Law" He received the M B E in 1946 in recognition of his research during the Second World War

International Conference on Phenomenology

An international conference on phenomenology, held in Brussels during April 12–14, enabled a number of philosophers interested in the work of Edmund Husserl and his school to come together in congenial surroundings Delegates attended from the following countries Belgium, France, Germany, Great Britain, Italy, Netherlands, Switzerland and the United States The discussions were noteworthy for the high level of the papers presented, and for the friendly (but by no means uncritical) atmosphere which characterized the whole of the proceedings The main items included the problem of intentionality, the comparative positions of Descartes and Husserl, scientific knowledge, language, and free-will Those taking part were particularly gratified at the opportunity of visiting the Husserl-Archiv at the University of Louvain, and of seeing for themselves something of the bibliographical work in progress Some idea of the magnitude of the task could be gained even from so brief a visit To Dr H L van Breda is due not only the appreciation of the visitors for such a well-conducted symposium they all realized how much the whole learned world is indebted to him and his colleagues for carrying through the stupendous task of conserving, transcribing and editing these unique manuscripts

Science Museum Past and Future

A special exhibition, entitled "Science Museum Past and Future", was opened at the Science Museum, South Kensington, London, S W 7, on April 20, and will continue to be shown during the normal Museum hours (weekdays and Bank Holidays, 10 a m – 6 p m , Sundays, 2 30–6 p m) throughout the Festival of Britain. The exhibition tells the story of the development of the Science Museum, a story which began with the Great Exhibition of 1851, among the many consequences of which was the setting up of the South Kensington Museum of Science and Art in 1857 , in 1909 the Science Museum began a separate existence and continued to develop into the institution as it is known to-day A part of the display shows the kind of exhibit which will be found in the new galleries to be opened when present building operations are completed, or later when it becomes possible to build the upper floors of the new Centre Block A dominating feature of the Exhibition is a group of three large pictures the Museum in 1857 , the Museum district of South Kensington as it appeared from the air recently , and an artist's impression of the Science Museum as it may one day appear when the building, as originally contemplated, extends from Exhibition Road to Queen's Gate An illustrated handbook, "A Short History of the Science Museum", is on sale at the Museum, price 1*s*

Law of Copyright

In a Parliamentary written answer, Mr Wilson, President of the Board of Trade, states that he has appointed a committee "to consider and report whether any, and if so what, changes are desirable in the law relating to copyright in literary, dramatic, musical, and artistic works, with particular regard to technical developments and to the revised International Convention for the Protection of Literary and Artistic Works signed at Brussels in June 1948, and to consider and report on related matters". The committee consists of Lord Reading (chairman), Dr T E Allibone, Mr J L Blake, Mr G Bristow Cooke, Miss B A. Godwin, Sir Henry Gregory, Mr E M Hugh-Jones, Mr J P Lamb and Mr F E Skone James The secretary to the committee is Mr H W Clarke, of the Patent Office, 25 Southampton Buildings, London, W C 2

Applications of Statistics to Archæology

In "Some Applications of Statistics to Archæology", a publication of the Service des Antiquités de l'Egypte (pp 37+19 figs , Cairo Government Press, 1950 , P T 120), after stressing the scant development that has succeeded the pioneer efforts in such a direction made by the late Sir Flinders Petrie almost three-quarters of a century ago, Oliver H Myers describes the use of statistical methods in the treatment of archæological data under the following four headings the relationship of stone and pottery in a stratified site , the sizes of sherds from surface sites in the desert , the hardness of ancient pottery , and the statistical examination of surface sites The techniques employed include correlation and regression, tests for the significance of the difference between two observed means and, under the fourth heading, elementary combinatorial theory Although the results of the last depend on some rather arbitrary assumptions and should therefore be treated with reserve, the author has shown that there are problems in archæology that lend themselves admirably to statistical treatment, and he has established his point by example rather than by precept, an approach likely to be effective in attracting the attention of archæologists unfamiliar with the methods of statistics In such a connexion it may be pointed out that the footnote on p 32 relating to tests for the significance of a correlation coefficient would probably confuse a beginner Again, the fact should perhaps be indicated that the test of the significance of the difference between two observed means given on p 16 is an approximate one (due to Cochran and Cox), to be used under suitable conditions, instead of the exact *t*-test, when it is desired to avoid the assumption of the homogeneity of the variances In the example that illustrates the method, however, the variances are almost identical and the use of the *t*-test would be justified

Joint Consultation

A broadsheet offering a practical approach to joint consultation in industry has been produced by a study group on behalf of the Institute of Personnel Management The broadsheet deals only with joint consultation inside industrial establishments and is not concerned directly with that aspect of joint consultation which is part of the established machinery for the negotiation of wages and working conditions between employers and the trade unions After a historical review of the development of joint consultative machinery in British industry since the First World War, a further section of the broadsheet discusses the reasons why joint consultation is necessary in industry Then comes much useful and eminently practical advice on the means of introducing joint consultation procedure into an organization, and this is followed by suggestions for keeping the machinery and spirit of joint consultation alive The broadsheet also contains details of the constitutions of joint consultative bodies at three firms where joint consultation is successfully practised, these are, the Works Council of the Northern Branch of High Duty Alloys, the Management Advisory Committee of Vauxhall Motors, Ltd, and the Works Council Scheme of Imperial Chemical Industries, Ltd The broadsheet may be obtained from the Institute of Personnel Management, Management House, Hill Street, London, W.1, price 2*s* 6*d*

Use of Plastics in Preparing Fossils

A USEFUL technical article by H A Toombs and A E Rixon, of the British Museum (Natural History), concerning a new development of the 'transfer method' in the preparation of fossils is contained in the *Museums Journal* (105, August 1950) The early technique of Holm in the preparation of graptolites, whereby the fossil was stuck to a glass slide by means of Canada balsam and the matrix removed by hydrochloric acid, is well known In 1948 Toombs, by using acetic acid instead of the mineral acids, showed how the method could be applied to most vertebrate remains in calcareous rocks It was necessary, however, to use a rubber cement instead of Canada balsam, which is attacked by acetic acid This rubber cement, however, had the disadvantage of being opaque, thus obscuring the original surface of the fossil By using the synthetic resin known as 'Marco Resin S.B 26 C', the transparency of the plastic allows the original side of the specimen to be seen Its adhesive powers are stated to be at least as good as those of rubber Laboratory details of the process are given in the paper, the dentary of a Eugnathid fish from Purbeck limestone being selected as an example

The Wandering Albatross

ALTHOUGH well known to sailors and others who make sea voyages, not many people have seen the wandering albatross in its breeding territory There are few places which this great sea-bird, with a wing-span of about seventeen feet, finds suitable for nesting, in the southern oceans there are probably not more than six islands Chief among them is Marion Island, one of the Prince Edward group, which is situated within the Roaring Forties Its suitability as a breeding place for the wandering albatross is probably due to the weather, which is extreme enough to exclude human beings but not severe enough to endanger the life of the young birds in their growth to maturity One human being who has observed the nest-building, egg-laying, incubation and other habits of the wandering albatross is J A Bennetts His account is recorded in a recent issue of *Scottish Zoo and Wild Life* (3, No 2, Jan 1951), the article is accompanied by some photographs showing the immature chick and the courtship behaviour of adult birds

Blundells' School Science Society

THE fifth issue of the magazine of the Blundells' School Science Society is yet another example of the splendid work being done at many boarding schools in Great Britain in the training and inspiration of young scientific workers In 1950, besides a series of general lectures to the Society ranging from the biology of the south-west Pacific to the production and measurement of high vacua, records were kept by individual boys to illustrate the local meteorology, entomology and ornithology Five hundred birds were ringed by the Ornithological Section of the Society, while one group of bird-watchers spent a camping week-end recording the birds of the Ponchydown area The Geographical Section toured South Devon to study physical formations in relation to land utilization, and a full account of their observations is presented The magazine also contains prize-winning essays describing original inquiries made by boys Those dealing with the reactions of nymphs of two species of may-flies to various ecological factors, variations in the sex ratio of the meadow brown butterfly and the investigation of double flower specimens of ladysmock are particularly noteworthy, as are a number of contributions by the teaching staff

Smithsonian Institution: Annual Report for 1948–49

THE annual report of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1949 (see *Nature*, 165, 641, 1950), has now been issued bound with the General Appendix (Publication 3996, pp 422+82 plates, Washington, D C Government Printing Office, 1950, 2 75 dollars) This includes reports of investigations made by collaborators of the Institution, as well as some memoirs of a general character or on special topics that are of interest or value to the numerous correspondents of the Institution Among these are Sir Harold Spencer Jones's Arthur Lecture on the determination of precise time, Prof F E Zeuner's address to the Royal Institution on time in evolution, H Friedman's paper on the "Breeding Habits of the Weaver-Birds a Study in the Biology of Behaviour Patterns", E H Walker's article "New Zealand, a Botanist's Paradise", and A V Kidder's paper on the archæological importance of Guatemala The rest of the papers have been previously published elsewhere, though some, such as those of E Hubble on the 200-in Hale telescope and some of the problems it may solve, and E D Walker on "Animal Behaviour", may not be easily accessible to British men of science

Technical Information and Documents Unit

THE Technical Information and Documents Unit, which for a number of years has been attached to the Board of Trade, has become a part of the Information Services of the Department of Scientific and Industrial Research The Unit has a large collection of unpublished documents, which contains valuable information on the production and use of substitute materials, and these are at the disposal of industry in Great Britain There is a small Technical Section for assistance in the selection of material to meet specific needs, and a reading room is provided for those wishing to make a detailed study of drawings and documents Alternatively, photocopies can be supplied at moderate charges The Unit is still at Lacon House, Theobalds Road, London, W C 1

Zoological Society of India. Officers

OFFICERS of the Zoological Society of India have been elected as follows. *President,* Prof K N Bhal, professor of zoology, University of Lucknow *Vice-Presidents* Dr S L Hora, director, Zoological Survey of India, Calcutta, Dr M A Moghe, principal, Amraoti College *Secretary* Dr M L Roonwal, forest entomologist, Forest Research Institute, Dehra Dun *Treasurer* Dr B S Chauhan, Zoological Survey of India, Calcutta *Editor* Dr B N Chopra, fisheries development adviser, Government of India, New Delhi *Members of Council* Dr H S Pruthi, plant protection adviser to the Government of India, Ministry of Agriculture, New Delhi, Dr N K Panikkar, chief research officer, Central Marine Fisheries Research Station, Mandapam, Prof A B Misra, professor of zoology, Banaras Hindu University, Prof H R Mehra, professor of zoology, University of Allahabad, Prof R V Seshaiya, professor of zoology, Annamalai University, Prof Bhaskaran Nair, professor of zoology, University College, Trivandrum

Information Bulletin of the U S National Academy of Sciences and National Research Council

THE United States National Academy of Sciences and the National Research Council are now issuing free of charge to all organizations and individuals directly associated with the Academy or the Research Council a new information bulletin, *News Report*, the first number of which (1, No 1, January–February, pp 20) illustrates the present concept of the scope of the new publication It includes an article on the scientific man-power situation in the United States, by M H Trytten, director of the Office of Scientific Personnel, another by O M Ray describing the functions of the Committee on Growth, created in 1945 to advise the American Cancer Society on the support of scientific research in problems of malignant and normal growth, and another by R W Crum on the work of the Highway Research Board Features such as "Science News", "Scientific Personnel" and "International Relations" record activities in different branches of science, openings such as Fulbright fellowships, trends in advanced training, and the activities of the international scientific unions Besides the calendar of international congresses included in the last-named feature, there are a further schedule of meetings during the year of affiliated societies and a calendar of meetings of the Academy and the Research Council, with a list of their new publications The annual subscription for those not receiving *News Report* automatically is 2 dollars, to be sent to the editorial office at 2101 Constitution Avenue, Washington 25, D C

University of London Appointments

THE following appointments have been made in the University of London Dr D R Crofts, to the University readership in zoology tenable at King's College of Household and Social Science, from October 1, Dr Werner Ehrenberg, to the University readership in physics tenable at Birkbeck College, from October 1

"New Inhibitors of the First Stage of the Blood-clotting Process"

DR E HECHT, whose communication under this title appeared in *Nature* of February 17, p 279, points out that it does not quite conform to the reprints which have been prepared thus, for "Sphingosine has the same solubility properties as Tocantins's 'anticephalin'[3] but differs from the latter by being thermostable" read (as in reprint) Sphingosine has the same solubility properties as Tocantins's 'anticephalin'[3], but the latter has been shown by partition chromatography to be a mixture of our non-protein activator, sphingomyelin and sphingosin" The following reference should also be added Tocantins, L M, and Carroll, R T, "Blood Clotting and Allied Problems", edited by J E Flynn, New York (1949)

Announcements

DR ILMO HELA, at present assistant professor of geophysics in the University of Helsinki and lecturer in meteorology in the Institute of Technology, University of Finland, has been appointed assistant professor of oceanography in the University of Miami Marine Laboratory Dr Hela will carry out research into problems connected with the Florida Current and other water-movements in the Gulf of Mexico and Caribbean Sea

THE Textile Institute, at 16 St Mary's Parsonage, Manchester, 3, is prepared to assist research conducted on cotton spinning, doubling and twisting, and is offering grants from the Frank Wright Memorial Fund to persons of British nationality Further details can be obtained from the general secretary of the Institute

THE Medical Research Council is offering a Kathleen Schlesinger fellowship for research on the origin and nature of cysts of the brain whether arising from tumours or not or for studies of other conditions of the central nervous system as the Council may permit The fellowship is ordinarily tenable at the National Hospital for Diseases of the Nervous System, Queen Square, London, W C 1, and is worth £700–1,000 a year for one year initially and renewable up to three years Application forms, obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, London, S W 1, must be completed by May 31

THE Development Commission announces that it is offering a few grants to British postgraduate honours students for training in research problems in marine or freshwater science, which is designed primarily to fit them for employment either in the fishery research services of the Ministry of Agriculture and Fisheries and the Scottish Home Department or in a marine or freshwater biological research institute The grants are worth £220–300 a year with extra university fees paid, together with a marriage allowance, and are tenable initially for one year but renewable up to a maximum of three years Application forms, to be returned by June 1, can be obtained from the Secretary, Development Commission, 6*a* Dean's Yard, Westminster, London, S W 1

THE Department of Inorganic and Physical Chemistry of the University of Leeds is arranging a postgraduate summer school on "Optical Crystallographic Methods", to be held in Leeds during September 3–14, which will be similar to those organized at University College, Swansea, in 1946 and 1947 The course will provide basic training in the theory and use of the polarizing microscope in the study of crystals and other birefringent materials, and in the applications of the instrument in other branches of science and technology Fees for the course are 15 guineas for tuition and 9 guineas for accommodation Enrolment forms, obtainable from Miss M Spink, Assistant to the Director of Extra-Mural Studies, University, Leeds, 2, must be completed by May 11

ERRATUM In the communication "Antitumourigenic Action of Steroids " by Prof A Lipschutz *et al* in *Nature*, February 10, on p 236, col 1, par 3, line 2, for "4 μgm" read "42 μgm"

NEUTRON-INDUCED ISOMERS OF XENON : A NEW ISOMER OF XENON-129

By INGMAR BERGSTROM
Nobel Institute of Physics, Stockholm

ACCORDING to nuclear shell theories, xenon should have isomers for each odd mass number equal to, or less than, 135 Xenon-127 and -135 show isomerism according to Seaborg's tables, xenon-131 [1] and xenon-133 [2] have recently been shown to have isomeric states The failure to observe the metastable xenon-129 could be due to a short half-life, soft conversion electrons or to its having nearly the same half-life and energy as another isomer of xenon

In order to search for the metastable xenon-129, xenon was irradiated in the Bepo at Harwell After irradiation the xenon activities were electromagnetically separated at this Institute The β-activity as a function of the position on the aluminium collector foil is shown in Fig 1 As can be seen from the graph, all odd mass numbers show β-activity except 135 and 125, the half-lives of which are too short to be observed The collector foil was cut into strips according to the activity spectrum of Fig 1 Each mass number was separately investigated with the β-spectrometer In this way we have obtained the following preliminary results for the long-lived xenon isomers produced by pile neutrons

Xenon-127 Fig 2 shows the β-spectrum of xenon-127, the half-life of which is about 30 days Electron lines of the following energies were found 22 8, 26 8, 51 8, 112, 137, 166 and 196 keV The first two lines have energies in agreement with the Auger lines K–$2L$ and K–L–M of iodine, which would mean that the long-lived xenon-127 decays mainly by K-capture to iodine-127, since no positive or negative β-particles were observed

The weak 51 8-keV line is interpreted as an L-line of a γ-ray of the energy 57 keV The corresponding K-line would then have the energy 23 8 keV and cannot be resolved from the first Auger line The intensity ratio of the first two Auger lines has been measured for xenon and cæsium, and this ratio was about 2 0 in both cases For the Auger lines found in the decay of xenon-127, this value was 3 0 indicating that about 0 3 of the intensity of the 22 8-keV line should be due to a conversion line

The intensities and energies of the lines at 166 and 196 keV are consistent with the K- and L-lines of a γ-ray of energy 200 keV The conversion lines at 112 and 137 keV are most probably K-lines γ-Rays of the energies 57, 145, 170 and 200 keV are then associated with levels in iodine-127 The sum of the energies of the first two γ-rays is equal to that of the fourth one within the limit of error The position of the third level from which the 170-keV γ-ray is emitted cannot be given unambiguously from $\bar{e}\bar{e}$-coincidence results in the β-spectrometer, due to reasons of intensity (*Note added in proof* Using a sodium iodide scintillation spectrometer, a γ-ray of the energy 365 keV was later found It should be noticed that the sum of the energies of the 170 and 200 keV γ-rays is equal to the energy of the 365 keV γ-ray)

Both activities belonging to xenon-127 have been investigated by Creutz *et al* [3], who in the longer activity report two electron groups with the range 35 and 350 mgm Al/cm^2 The first group is consistent with our measurement, but the second group (corresponding to a γ-energy of about 900 keV) might be due to contamination, since it is not found in our separated sample Creutz *et al* have suggested that the 75-s activity is responsible for the isomeric transition Our measurements indicate that the 30-d activity is associated with the decay of the ground-state of xenon-127 This isomer would be an exception to predictions based on the nuclear shell model of M G Mayer, which has been pointed out recently by P Axel[4]

Xenon-129 A new xenon activity of mass number 129 has been discovered The half-life is 8 0 ± 0 2 days and the γ-energy of the isomeric transition 196 ± 2 keV The intensity ratio of the K and $L + M$ conversion electrons is about 2 1 The half-life and the energy make the multipole order 5 probable Nuclear shell theory predicts the spin

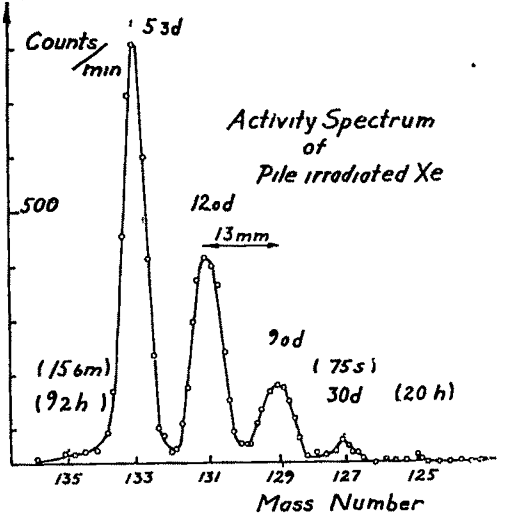

Fig 1 Xenon activity spectrum The real half-width of the activity lines is 3 mm The broadening of the lines in the figure is due to the width of the lead slit used close to the β-tube Half-lives within brackets not measured in this investigation

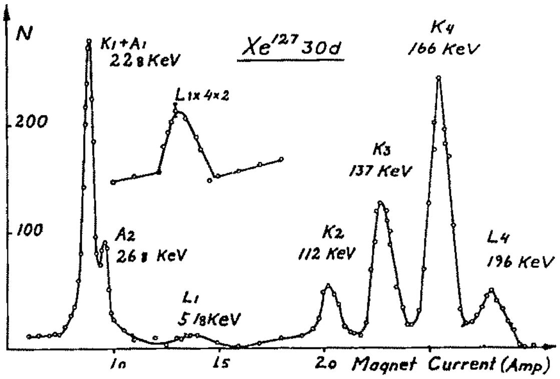

Fig 2 Conversion lines of electromagnetically separated xenon-127

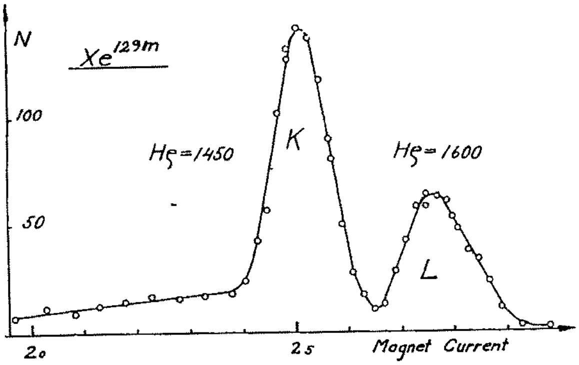

Fig 3 Conversion lines of electromagnetically separated xenon-129

11/2 for the isomeric state The spin of the ground-state of xenon-129 is 1/2 The radiation would then be electric As the spin of the stable xenon-131 is 3/2, the isomeric transition would in this case correspond to a mixture of electric and magnetic radiation, provided the isomeric state has the spin 11/2 It is then surprising that $N_K/(N_L+N_M)$ for xenon-129 and -131 are so close (~2 1 and ~1 9 respectively) This similarity can be explained if the spin of the isomeric state of xenon-129 is 9/2, which, however, would be an exception to the predictions of the *J*—*J* shell theory

As no other conversion lines were found in the xenon-129 sample, it is possible that the isomeric state is the lowest excited level in xenon-129 The β-transition $^{129}I \rightarrow {}^{129}Xe$ would then occur between the ground-states Because of the low β-energy, 120 keV [5], and the spin difference 7/2–1/2 [5], the *f t*-value for the β-transition would be very high, in agreement with the long half-life of iodine-129 [5]

Xenon-131 The *K*- and *L*-conversion lines of an isomeric γ-transition with an energy of 163 keV have been observed

$$\frac{N_K}{N_L + N_M} = 1\ 9$$

Thus the xenon isomer produced in the decay of iodine-131 [1] is identical with the neutron-produced activity

Xenon-133 In addition to a β-continuum and the strong conversion lines of an 81-keV γ-ray, we have observed the weak conversion lines of a 232-keV γ-ray, which has recently been reported by us[2] as being associated with an isomeric transition in xenon-133 The resolving power of the β-spectrometer was 1 per cent in this measurement and about 5 per cent in the other cases As

$$\frac{N_K}{N_L + N_M} = 2\ 3,$$

an isomeric transition associated with xenon-133 seems to be well established

Further communications dealing with these problems will appear in *Arkiv for Fysik*

We wish to express our thanks to the Isotopic Division at Harwell for their excellent service and their interest in the rare-gas irradiations

[Dec 11

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A LONG-PERIOD CHANGE IN RADIO-FREQUENCY RADIATION FROM THE 'QUIET' SUN AT DECIMETRE WAVE-LENGTHS

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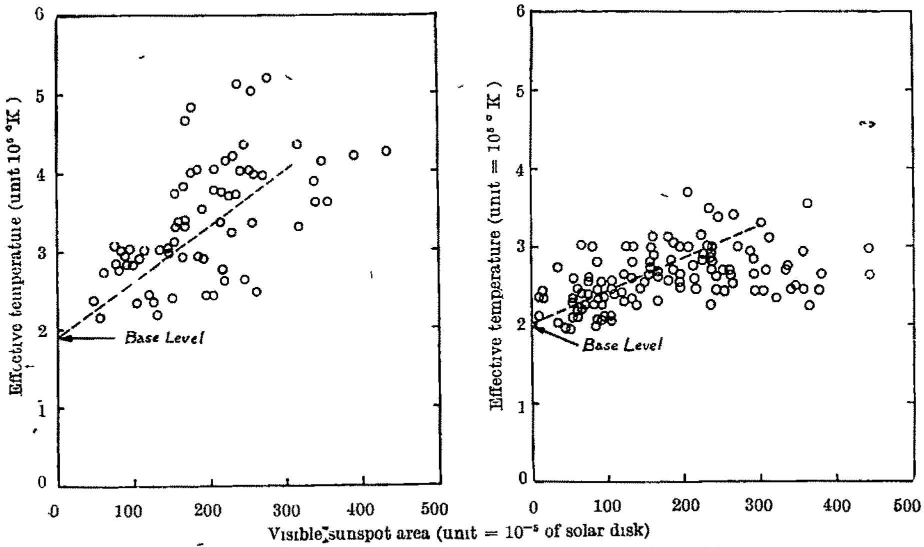
AT decimetre and centimetre wave-lengths, the radiation flux from the sun changes from day to day in a manner related to the daily change in sunspot area[1,2] or number Pawsey and Yabsley[3] found that this radiation could be divided into two components, one of which was correlated with the visible sunspot area, and the other identified with thermal radiation from the quiet sun[4–7] They pointed out that some observations then available suggested a change in the latter component during the sunspot cycle, but that more observations were required before this could be established Such a change was predicted by van der Hulst[8], on the basis of an observed decrease in the electron density of the corona towards the minimum of the sunspot cycle

At this laboratory, observations of solar radiation have been made over a large part of the period since 1947 on wave-lengths of 50 and 25 cm , and since 1948 on 10 and 3 cm Results of measurements on 10 7 cm made by Covington[9] during the period 1947–49 are also available The records have been examined to see if the effective temperature of the quiet sun is changing in the period since the maximum phase of the solar sunspot cycle

Freq / Year	Percentage increase over base temperature per hundred units sunspot area			
	50 cm	25 cm	10 cm	3 cm
1947	25	35	38	5
1949–50	12	20	18	5

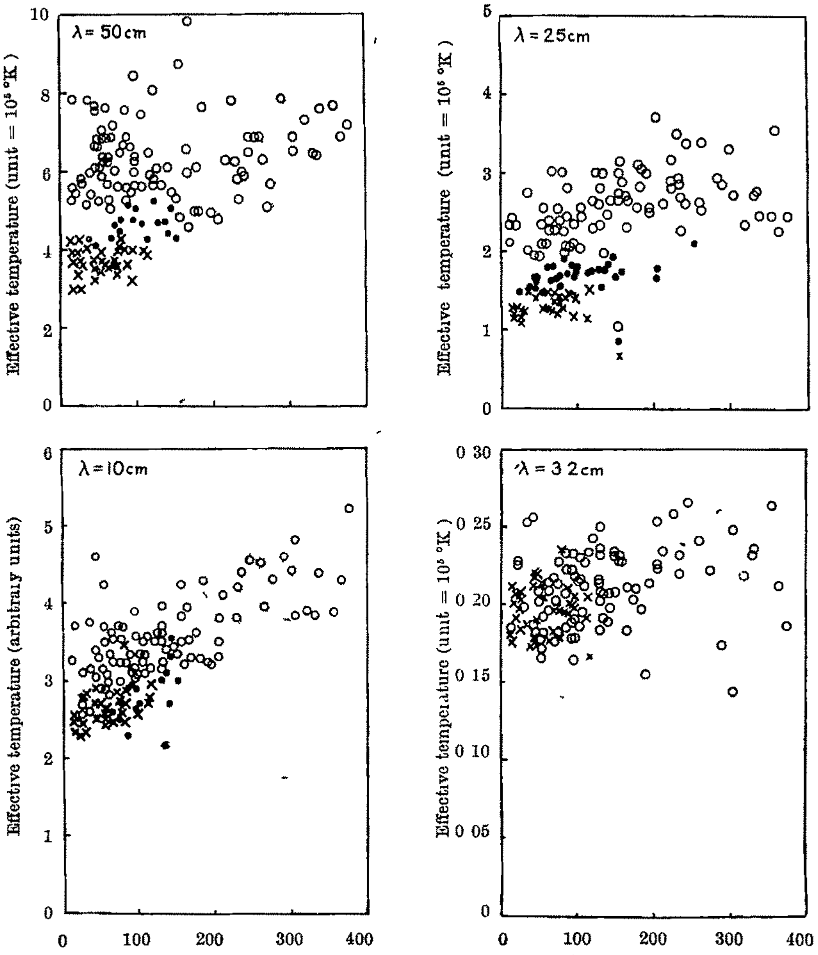
Unit of sunspot area = 10^{-6} of the solar disk

In Fig 1 the daily value of the effective solar temperature at a wave-length of 25 cm is plotted against visible sunspot area for two periods the first from August to November 1947, when the average sunspot area was approximately 210 × 10^{-6} of the disk area, and the second from September 1949 to June 1950, when the average sunspot area was 160 × 10^{-6} The dotted lines indicate the average temperature for a given value of sunspot area, and when extrapolated to zero sunspot area[3] give the 'quiet sun' or 'base' temperatures It is seen that, although there was a significant reduction in the slope of the line of best fit relating effective solar temperature to sunspot area, the base temperature did not change appreciably in the two-year interval between the two sets of measurements A similar change of slope without change of base-level was observed on a wave-length of 50 cm Covington, on the other hand, reported to the 1950 Conference of the Union Radio-Scientifique Internationale that his 10 7-cm records show a gradual fall in effective solar temperature of about 20 per cent between 1947 and 1949



Left, August–November 1947, right, September 1949–June 1950

Fig 1 Comparison of effects of sunspots on effective solar temperature during 1947 and 1949–50 at a wave-length of 25 cm



Left, top and bottom O—O—, January–July 1950, ●—●—, August 1950, ×—×—, September–October 1950 Top right O—O—, January–June 1950, ●—●—, July–August 1950, ×—×—, September–October 1950 Bottom right O—O—, January–August 1950, ×—×—, September–October 1950

Fig 2 Scatter diagrams of effective solar temperature during 1950, showing drop in base-temperatures at decimetre wave-lengths in the later months

In 1950, however, a marked drop in the base-temperatures was observed on wave-lengths of 10, 25 and 50 cm, commencing in July on 25 cm and in August on 10 and 50 cm This is illustrated in Fig 2, which is similar to Fig 1 but shows the results of observations on 3, 10, 25 and 50 cm, with recent observations indicated distinctively On 25 cm, all but one of the daily readings of effective temperature during July–September fell below all previous ones for 1950, despite the inclusion in the latter of many cases of smaller sunspot area At a wave-length of 3 cm no change greater than the uncertainty of observations was found Similarly, at the longer wave-length of 150 cm, Dr C W Allen has informed us that he has detected no change greater than the experimental uncertainty of 10 per cent

The observed decreases on wave-lengths of 3, 10, 25, 50 and 150 cm are 0, 20, 45, 35 and 0 per cent, so that the effect appears to be confined to the decimetre wave-lengths This is consistent with a decrease in coronal electron density, as suggested by van der Hulst

The observations given here appear to establish that the base-level of the effective solar temperature is subject to long-term variations It is proposed to investigate the relation between these changes and the solar cycle when observations have been carried out over a sufficiently long period

We wish to acknowledge the help of Dr J L Pawsey and Messrs H C Minnett and D E Yabsley, who have been associated with the work, and Messrs G Fairweather, A J Harragon and G H Trensky, who made many of the observations

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GOVERNMENT AID FOR THE SOCIAL SCIENCES

TWO recent issues of *Planning* are broadsheets on "Government Aid for the Social Sciences"*, in which Political and Economic Planning has reviewed some of the developments in this field since the end of the War The success with which some of the techniques developed in the social sciences were used during the War, the increasing emphasis on social change, the special need in Great Britain for achieving a greatly improved rate of productivity and the realization that this depends to no small extent on improved human relations have all persuaded the Government to make increased provision for the needs of the social sciences The first broadsheet examines the position in the universities, while the second reviews what has been done under the Research Councils, by the Departments of State and as regards the human factor in industry

The stimulus came largely as a result of the recommendations of the Clapham Committee on the Provision for Social and Economic Research, which, however, as regards finance, confined its recommendations to the universities *Planning* considers that the support that has been forthcoming in the past three or four years has, on the whole, been generous, and that it is no fault of the Government if, in terms of endowment and prestige, the social sciences are still the poor relations of the natural sciences While the full effect of the increased provision cannot yet be judged, the broadsheets suggest that a critical point is now being reached and that important matters are coming up for decision which will determine the future of the social sciences for many years to come

Taking as a guide the Clapham Committee's interpretation of its field as including economics and economic history, sociology, social anthropology and social psychology, political science, demography, economic and social statistics, and certain branches of medical statistics and law, *Planning* estimates that university expenditure on the social sciences in 1948–49 was £397,008, or 4 2 per cent of the total, as against £115,909 or 3 0 per cent in 1938–39 The university staff has increased from 291 in 1937–38 to 604 in 1949–50, and in 1948–49 1,057 honours degrees were awarded, or 10 2 per cent of those awarded in all subjects, as against 335 or 6 4 per cent in 1938–39 Most of the money has gone to increase the teaching staffs, and here, particularly in sociology and related subjects, expansion has been limited by the scarcity of well-qualified people Some further expansion of staff still seems to be needed, and the distribution over the different subjects is still uneven

The first question for decision is whether the earmarked grants for the social sciences should continue in the next quinquennium or whether they should be merged in the general or block grants made by the University Grants Committee to universities *Planning* clearly does not consider that a reasonably satisfactory level of development has yet been reached in the social sciences for the earmarked grants to be discontinued so early The social science faculties in each university would thereby be involved in a struggle with other faculties over the distribution of the money, in which their early stage of development might be a serious handicap and in which it might be difficult for them to obtain even the same money as before

Attention is also directed to a further reason for giving special treatment to the social sciences. So far, the amount of new research which could fairly be attributed to the earmarked grant is comparatively small, chiefly because the universities have rightly in this phase concentrated on training the social scientists of to-morrow This is in accordance with the priority generally recommended in the report on scientific man-power The purposes of the Clapham Committee will not be fulfilled, however, unless more research opportunities are created, and the problem in the next quinquennium is likely to be one of finding research jobs for some of the abler students who are now being produced in greater numbers

The universities still depend mainly on the great charitable foundations for research in this field, the Rockefeller and Nuffield Foundations alone providing £296,000 over periods of from two to ten years, and the Clapham Committee has urged that more money should be provided from official sources on a permanent and routine basis *Planning* hopes that the universities will also seriously consider whether, if funds are insufficient to develop every side of the work, emphasis should not, during the next phase, be put on research into one of the less well-established disciplines of sociology, social anthropology and social psychology

What matters most to the social scientist is the number of opportunities which exist for research and the use which is made of his special skill and experience and also of the results of his work This makes necessary a review of the activities of the various Government bodies and other institutions by which the grants are made The extent of these activities is illustrated, rather than comprehensively described in the second broadsheet

While the main work of the Medical Research Council falls outside the province of the social sciences, work on some aspects of physiology and psychology, especially in the fields of industrial and occupational health, provides some of the basic material about human behaviour for the social scientist Besides the Applied Psychology Unit at Cambridge, there are the Group for Research in Industrial Psychology, the Occupational Psychiatry Unit at the Maudsley Hospital, the Social Medicine Research Unit at the Central Middlesex Hospital and the Statistical Research Unit at the London School of Hygiene and Tropical Medicine The Department of Scientific and Industrial Research has recently begun to show a direct interest in the social sciences arising out of the 'operational research' approach to industrial problems and the encouragement given to research associations to make detailed productivity studies The Advisory Council has expressed the opinion that the research associations should be free to undertake investigations, including economic and sociological studies, in any field of science and considers that the linking of physical science and engineering with economic studies within industry holds much promise for the future The Development Commission is also able to make grants from the Development Fund for investigations and surveys of special rural problems and has already made grants for surveys of small-scale industries in country towns in various regions

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* Government Aid for the Social Sciences (Political and Economic Planning, 16 Queen Anne's Gate, London, S W 1)

From the Colonial Development and Welfare Funds some £776,000 has been available for social science and economic research, and a Colonial Social Science Research Council has been set up to administer grants for such purposes The Council has already established three research institutes—in the West Indies, and in East and West Africa—while the work of the existing Rhodes-Livingstone Institute in Central Africa has been expanded by a grant of £100,000 over five years Research into economic problems affecting the Colonies is supervised and supported by the Colonial Economic Research Committee With minor exceptions the Departments of State dealing with economic and social affairs have taken little direct interest in research in this field, although some, like the Home Office and the Ministry of Health, have specific powers under recent Acts to commission or make grants for research The recent report of the Committee on Qualifications of Planners stressed the need for the social sciences to contribute to the work of the Ministry of Town and Country Planning, but the activities of the very few research officers of the Ministry are neither properly co-ordinated nor, for the most part, concerned with any but short-term questions The Ministry of Education carries out no research but has made grants of more than £20,000 since the end of the War to the National Foundation for Education and Research, which, however, is left free to plan its own research and has an income of £8,000–9,000 a year, chiefly from corporate subscriptions

Of the work of the so-called 'economic' Departments, including under this head the General Register Office, the broadsheet remarks that the immense amount of work of interest to the social scientist is handled by the Departments concerned rather as technical processes than as research jobs One particular project mentioned is the study of industrial location which, in 1948, the Industrial Location Division of the Board of Trade invited the National Institute of Economic and Social Research to undertake There are also the various Commissions, such as the Monopolies Commission and the Royal Commissions on Population and on the Press, which have instituted extensive inquiries, and the Government Social Survey, which was established in 1946 as a permanent part of the machinery of government, is also participating in the wider research field The Committee on Industrial Productivity, set up in December 1947, was given a Panel on Human Factors affecting Productivity, and, although the parent Committee has now been dissolved, the work of the Panel is being continued, divided between the Medical Research Council and the Department of Scientific and Industrial Research

The general conclusion reached by *Planning* in these broadsheets is that the work being carried on in the social sciences has so far been more impressive in scale than in quality Some concern is expressed that the expansion of the teaching facilities in the social sciences at the universities will not of itself attract a sufficient proportion of the best undergraduate material or provide adequate research opportunities for the newly trained people There are also many social and economic problems which still await systematic investigation The independent research institutes have also an essential contribution to make to the advancement of research in the social sciences, particularly on more 'applied' problems and where team-work by people trained in different disciplines is required The administration of funds in support of such institutes would be more conveniently conducted by a Social Science Research Council, and Political and Economic Planning suggests that the establishment of such a Council should be reconsidered in the light of a full and critical examination of the work and needs of these research institutes Finally, the broadsheet welcomes the decision of a representative group of social scientists to establish a new professional association to bring together all those who are interested in the scientific study of society and to undertake the various functions appropriate to an organization with this object Such a body should have an excellent opportunity of raising the standards and the prestige of the particular social sciences with which it will be concerned

FUTURE OF THE OVERSEAS FOOD CORPORATION

SINCE the second annual report of the Overseas Food Corporation was issued last autumn, both the Corporation and the Government have accepted, in their main essentials, the recommendations in the report of the Kongwa Working Party for restriction of cultivation over the next three years to about 12,000 acres These recommendations were also taken into account by the Corporation in preparing a revised long-term plan for the East African Groundnut Scheme This plan has now been issued as an appendix to a White Paper on the Future of the Overseas Food Corporation* in which the Government announces its decision to write off the £36 millions already expended on the scheme and to transfer to the Colonial Office the responsibility for the revised plan which is now regarded as a scheme of large-scale experimental development to establish the economics of clearing and mechanized, or partly mechanized, agriculture under tropical conditions Even on the modified basis now proposed, the scheme cannot fail to be an important contribution to the economic development of Tanganyika, and the results of the experiments being undertaken may be of value in many other tropical territories

The Corporation's new proposals cover a period of seven years up to 1957 They envisage no further land-clearing at Kongwa or Urambo after the end of 1950 Of the 90,000 acres cleared at Kongwa, about 24,000 acres are to be set aside for agriculture, of which 12,000 will be under crop each year, the remainder of the cleared land being available for grazing The object is to conduct fully costed field-scale trials on a limited acreage for three years, when a further review will be made, in the light of the results achieved, of the possibility of again extending arable agriculture over some or all of the remainder of the cleared land. It is not expected that more than 45,000 out of the 65,000 acres cleared at Urambo will be available for agriculture for the harvest of 1951; but 60,000 acres will be ready later. Of the 20,000 acres felled in the Southern Province, 7,000 acres will be available for agriculture for the 1951 harvest, and during the current wet season a further 40,000 acres are being felled with the two land-clearing teams built up for that purpose. Thereafter, the Corporation proposes drastically to reduce the tractor force to the minimum required to complete the remaining operations on this 40,000 acres and to adopt a slower and cheaper method of land clearing involving the substitution of hand labour for part of the work at present done by machines. Under this scheme the same tractor force might be expected to fell an additional 15,000 acres of land per year, and the Corporation contemplates that the same acreage would be brought into cultivation each year, giving by 1957 a total of 105,000 acres fully cleared for agriculture and a further 35,000–45,000 acres in various stages of preparation. In this revised scheme all three areas, with one exception at Kongwa, will be farmed in units of 1,500–6,000 acres, under intensive supervision by men who can gain an intimate knowledge of the land which they farm, instead of the 30,000-acre units originally proposed. The Corporation stresses the need for continuity of agricultural operations over a period of at least seven years in the interests both of efficiency and of the morale of the staff which, it is now admitted, has suffered from past uncertainties and changes of plan.

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* Overseas Food Corporation The Future of the Overseas Food Corporation (Cmd 8125) Pp 20 (London H M Stationery Office, 1951) 9*d* net

The Government is satisfied that some assurance of continuity is reasonable and indicates its firm intention, provided the costs do not greatly exceed the estimates, that funds should be provided to enable farming operations to continue for seven years. It approves the proposal for a review in 1954 before deciding on what scale further felling and clearing should be undertaken. It is estimated that over this seven-year period a further £6 million will be required, without allowing for any contingencies or for any bush clearing after 1954. While the Corporation does not consider that on the basis of the new plan its needs alone would justify the completion of the new part of Mtwara, in the light of decisions by the Tanganyika Government and the East African Railways and Harbours Administration to construct and improve feeder roads and to extend the railway sixty miles westward from the groundnut area, the Corporation has agreed, with the concurrence of the Government, to complete the port and the railway connecting it with the existing line.

The conclusions on which this revised plan is based are clearly stated in the appendix. First, the attempt to produce crops economically on land which has been cleared for agriculture at a great cost in money and human effort must be sustained for a sufficiently long period—put at a minimum of seven years—to show conclusive results. Second, the areas selected for development are capable of giving good yields of groundnuts and have done so on the small experimental farms. The problem yet to be solved is that of reproducing something approaching these results on a large scale. It is now concluded that the groundnut is not a plant which lends itself readily to mass methods over vast acreages, and that the attainment of economic yields demands intensive farming. Third, the clearing of forest and bush by wholly mechanical means from land of the type occupied by the Corporation has proved impracticable within either the time or the cost envisaged in earlier plans; it cannot be done at an economic cost in relation to the value of the arable land created. Fourth, the Corporation considers that it would be wasteful not to utilize, at least for a maximum tree-felling effort (the most efficient and economical of the mechanized operations) during the coming wet season, the accumulated resources in communications, installations, machines and man-power which have been built up over the past three years. Finally, provision must also be made from the capital remaining at the disposal of the Corporation to cover commitments, mainly worthless, from the past and for some reserve against unforeseen contingencies in the execution of any revised plan.

The plan formulated is accordingly designed to establish, by agricultural practices and scientific experiments, a pattern of agriculture which will utilize economically all the cleared land available and which, if successful, will point the way to future development; to equip all the cleared land with permanent installations and adequate machinery and implements, without which the capital expenditure on land clearing will be wasted; and to establish that sense of permanence and stability without which no constructive objective can be achieved efficiently. The plan should also execute in the Southern Province the first stage, extending to 1957, of what may become, as a result of a later review of the economic prospects, a scheme to develop the total area capable of being serviced from Nachingwea, utilizing the installations, machinery and man-power already accumulated.

The revised plan thus appears to offer reasonable prospects of turning to the best account the resources already engaged and the experience gained. The technical and research aspect may possibly be over-stressed, for the proposals scarcely bring out the importance of one lesson taught by the failure of the larger scheme, namely, the necessity of training the indigenous people in modern agricultural methods if balanced progress in development is to be achieved. Stress is rightly laid on the importance of morale and the necessity for reasonable compensation for the thousand or so European staff who will become redundant during the next three years; but something could well have been said of the part that Africans are to play in the scheme, for its ultimate success must also depend on the transformation of inexperienced Africans into successful farmers able and willing to reclaim and maintain their own land.

CENTRAL DRUG RESEARCH INSTITUTE, INDIA

THE Council of Scientific and Industrial Research, India, launched six of its national laboratories during 1950. It has planned eleven such institutions so far, and the remaining five its energetic director, Sir Shanti Swarup Bhatnagar, expects to launch in the course of 1951. The seventh of the series, dedicated to research on drugs, was the occasion of an impressive inaugural ceremony in a very picturesque setting in a Lucknow palace on the bank of the Gomati on February 17.

The imperative need for a Central Drug Research Institute was stressed in 1947 by the Pharmaceutical and Drugs Committee of the Council, and an outline scheme for such a body was drawn up by Dr B Mukerji A planning committee came into being early in the following year, and a few months later the assistant director (planning) was appointed After examining various suggested locations, the Committee decided on Lucknow, as it is a university town with a medical college and a first-rate teaching hospital, the Government of the State offered the historic Chattar Manzil Palace as a free gift to the Council to house the proposed Drug Research Institute

Lucknow is proud of its many eighteenth- and nineteenth-century buildings, and of having evolved an architectural style of its own, ornate and tortuous, and often seeking to combine Mughal and Western elements Chattar Manzil ranks high in Lucknow architecture An army engineer, Claude Martin, built part of the Manzil, but it was later acquired and extended by successive Nawabs of Oudh The British converted the Nawabs' harem into a club, and now renascent India is transforming it into a modern research centre The architect and engineers of the U P Government and the assistant director (planning) have had a difficult task in effecting this metamorphosis For the present, only a portion of the four-storied palace has been converted, but this covers quite 25,000 sq ft Certain other portions cannot be adapted without considerable expense The alterations, including gas and water installation and fresh electric wiring, have cost about Rs 7 lakhs A new building would no doubt have cost about seven times this amount When extensions become necessary, these will be planned in architectural harmony with the Lucknow-style palace For the present, the only altogether new additions to the buildings are the gas house and the animal house The animal house when completed and equipped will have cost about Rs 2½ lakhs Four of its rooms will be air-conditioned—showing, Sir Shanti humorously remarked, tender consideration for animals, for in the main laboratory only the director's room is being air-conditioned A nucleus for a workshop has already been set up in one of the outhouses, but in the near future a more suitable workshop will have to be built

The Institute will promote drug research, test and standardize drugs discovered by the Institute, provide expert advice for their further development and production, offer research facilities and advice to scientific workers, universities and industry, organize controlled clinical trials of drugs in clinics, and disseminate scientific knowledge relating to drugs

To begin with, the Institute has five divisions (1) chemistry, (2) biochemistry, (3) pharmacology, (4) microbiology and parasitology, and (5) clinical science A sixth division (botany, including pharmacognosy) is proposed for the near future In addition to these scientific divisions, the Institute has an animal house, an intelligence and statistical section including a central library, a museum, the necessary administrative sections and a cafeteria A first-rate herbarium would be necessary for the pharmacognosy division

The inauguration ceremony, presided over by the Governor of the United Provinces, Sir H P Mody, opened with a speech by the Hon Mr Sri Prakasa, Minister for Natural Resources and Scientific Research, who referred to India's creditable contribution to ancient medicine, narrating the mythological origin of the science with the birth of Dhanvantri, physician of the gods, who brought with him the 'Three Bitters' and 'Three Astringents' —the simples out of which a pharmacopœia grew The Premier and the Health Minister of the United Provinces (the latter is also chairman of the local committee for the Institute) referred to the importance of the drug industry in India's national economy and to the plentiful sources of drugs in India and more particularly in the United Provinces. The Hon Rajkumari Amrit Kaur, Minister for Public Health, also stressed the importance of the drug industry and India's contribution to early medicine Sir Shanti Bhatnagar said that the Institute would have to be a blending place of old and new knowledge "It will be one of the essential functions of this Institute to subject remedies used by *vaids* and *hakims* to trial and if investigations prove them to be really effective to propagate their use to save the world from misery and disease"

Pandit Nehru, in declaring the Institute open, said that he attaches great importance to research on drugs, but he has no sympathy with the "valetudinarian outlook on life", and he ridiculed the polite conversation which suggests that being healthy and robust is vulgar, he remarked that in his youth he had been fascinated by Samuel Butler's satire and the wholesome Erewhonian practice of sending criminals to hospital for treatment while awarding a term in prison to invalids Pandit Nehru paid a tribute to the devotion and industry of those entrusted with the hard work of the initial stages of the Institute, and said that it had been lucky in having had the benefit of Sir Edward Mellanby's guidance, even though he had only been available as director for about three months He announced that Sir Edward would be succeeded by Dr B Mukerjee, director of the Drug Institute in Calcutta

The Institute has had the advantage of guidance from Colonel R N Chopra, to whose pioneer work on drug research tributes were paid by Sir Shanti Bhatnagar as well as by Sir Edward Mellanby Colonel Chopra was present at the inauguration and said "This is a great day for drug research in India" He complained that the cost of essential drugs has recently been mounting higher and higher, whereas the masses in India are "too poor to obtain treatment for minor ailments, to say nothing of specific remedies required to fight disease The majority of these are of foreign origin and their cost is prohibitive because commercial firms abroad have spent enormous sums of money on their development" Drug research in India hitherto has been sporadic, unorganized and haphazard, the Institute would put it on a sound, systematic and permanent basis Thanks to its varied climatic, meteorological and topographical features, India, Colonel Chopra pointed out, has one of the richest floras in the world "Plants containing medicinal principles grow abundantly and about 2,000 of 11,000 species found in India are enumerated in the indigenous medicine" Even work on plant chemistry has largely confined itself to alkaloids glucosides and essential oils An enormous field, yet unexplored, is open to investigators if plant research receives a new orientation in the new Institute and plant antibiotics are also studied Recent work in India has shown the presence of substances of antibiotic nature, active against pathogenic bacteria, in common Indian plants Collaboration between chemists, pharmacologists botanists and micro-biologists in the new Institute is full of possibilities not only of scientific and academic interest but also of great practical economic importance to India.

Sir Edward Mellanby emphasized that, for a nation's health, drugs can at best form the second line of defence; the first line must always be the public health services. He referred to ancient India's contribution to the foundation of medicine, especially in the treatment of disease by plant products. It is a paradox, he said, that "whereas a large part of the plants, from which official drugs in the pharmacopœia are made, are already grown in this country, yet many of these drugs are imported in large quantities".

METHODS OF LABOUR STATISTICS USED BY LONDON TRANSPORT

IN a paper submitted to the Institute of Actuaries and entitled "Personnel Statistics and Sickness Absence Statistics", Messrs. F. H. Spratling and F. J. Lloyd, of the London Transport Executive, discuss the importance of a systematic collection of data on numbers of staff, wastage and sickness absence in a large organization. Simple enumerations of the numbers employed as well as turnover and sickness absence rates, they argue, do not form a sufficient basis for the development of a successful staff policy. Policy should be based on a study of the age and length-of-service distribution of the population, which makes it possible to estimate the numbers of skilled and experienced staff that will be required and to calculate the financial cost of pensions and sick pay.

To meet the requirements of administrative, financial and medical planning, London Transport, which employs a hundred thousand people, has developed specialized methods of collecting and analysing personnel statistics. The information, obtained from the employees' personal record files at the various employing departments, is collected and recorded in a Central Record of Staff Statistics which consists of three files of punched cards. The Main File gives up-to-date details for each member of the active staff. A duplicate copy, made on December 31 of each year, is used to work out the age and length-of-service distribution of the population, and appears to be a useful device for adoption in personnel departments. The Wastage File consists of cards providing information for all leavers. The Sickness Absence File consists of cards for each spell of sickness absence; this differs from systems employed elsewhere, which collect on to one card all the absences of an individual employee.

Wastage is usually measured by the labour turnover rate, which expresses the annual number of leavers as a percentage of the average number employed during the year. This rate shows similar shortcomings to the crude death-rate, which ignores demographic factors such as the age-distribution of the population, and is not suitable for comparing experiences of different populations. In vital statistics it is therefore customary to calculate age-specific mortality rates. Similar techniques can be applied to turnover statistics, and the authors describe in detail a method of calculating specific rates which refer the number of leavers in a special age and length-of-service category to the number employed in that category. A method for making adjustments for irregular rates of recruitment is also discussed. The problem of calculating specific rates for very short periods is complex, and an alternative approach is the statistical analysis of the behaviour of new entrants in a given period of time.

Just as age-specific mortality rates are used for the construction of life-tables, so specific wastage rates can be used for constructing service-tables, and for estimating the trend of the working population. This represents an advance over the ordinary turnover rates which cannot be used for making accurate forecasts of staff changes. It is hoped that the specific wastage rates will prove a more reliable guide for estimating future employment requirements.

In the section on sickness absence, Mr. Spratling and Mr. Lloyd discuss the difficulties of collecting comparable sickness absence statistics. Absence rates are known to vary with the period for which sick employees are kept on the books. The authors advocate six months as a reasonable period. Other research workers consider a period of one month more suitable, and suggest that prolonged absentees should be kept on a special register, and excluded from the ordinary sickness returns. The authors recommend that separate records should be kept of short absences lasting less than four calendar days, and of long absences lasting four or more calendar days. This does not follow the line adopted by other organizations, which divide sickness into certified and uncertified sickness, where certified sickness may be less than four days, and the statistics are based on working days lost, not calendar days.

Mr. Spratling and Mr. Lloyd distinguish three absence-rate functions: the attack rate, which shows the average annual number of absences per worker; the average length of sickness absence during the year; and the sickness absence rate, which is the product of the other two functions. The punched-card system makes it possible to analyse the records by age, length of service, duration of absence and type of disease. For the latter purpose, London Transport uses the three-figure International Statistical Classification of Diseases and Injuries adopted in 1948 by the United Nations World Health Organization, and a discussion of suitable groupings of various diseases is included in the paper.

A number of appendixes discuss the recording and classifying of sickness absences, ways of dealing with absences occurring in separate calendar years, and methods of calculating specific absence rates. The latter refer the number of days lost by special groups of staff to the numbers employed in those particular groups. It should be pointed out that the absence rates used by London Transport are not the usual percentage absence rates used in factories, but are a measure of the number of days lost per working year, which may be 250–300 per worker, while the percentage rates refer to 100 working days.

The specific sickness absence rates, like the specific wastage rates, have the advantage that they can be used for making reasonable forecasts of the expected sickness absence of a population (given normal climatic conditions and the absence of epidemics) if particulars with regard to age, sex and length of service of the numbers exposed to risk are known. A knowledge of the likely future loss of time might prove very useful for the production, personnel and planning departments of industrial organizations.

HILDE BEHREND

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

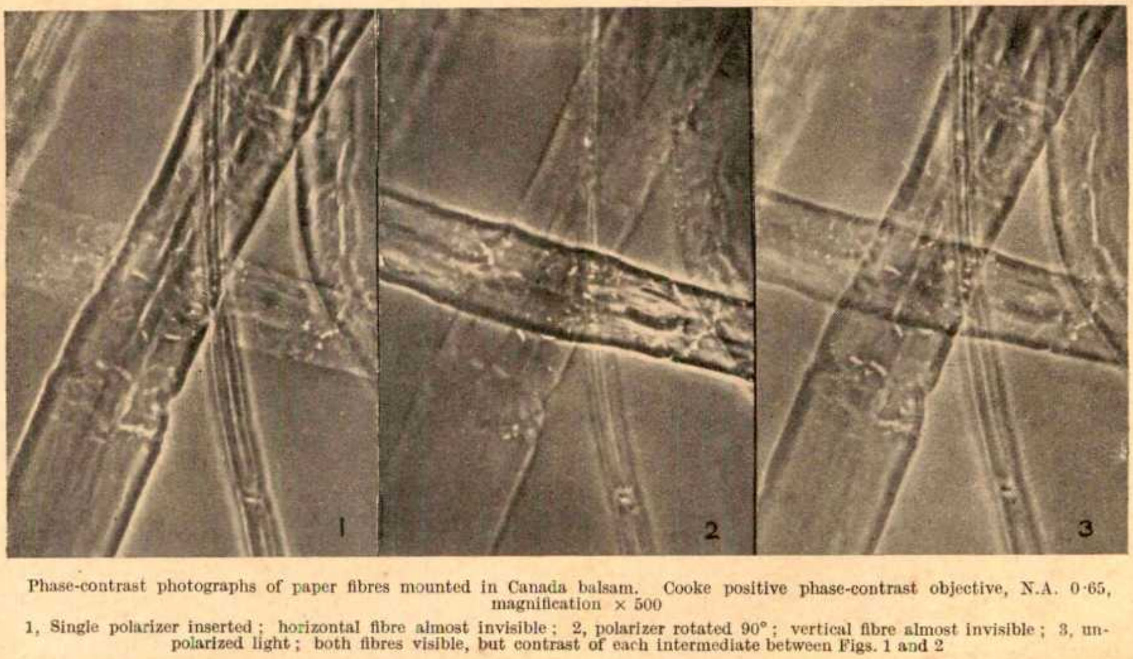
'Phase-Contrast' Methods and Birefringence

IT is well known that in determining the refractive index of microscopic anisotropic objects by the methods of Becke or Schroeder van der Kolk, and their variants, it is essential to use properly oriented plane-polarized light. Now phase-contrast microscopy, interference microscopy, *Schlieren* and dark-ground illumination are essentially methods for revealing small variations in refractive index (or strictly, optical path). It would therefore seem desirable, when using these methods with birefringent objects, to employ polarized light. I have found this to be the case in certain circumstances.

The accompanying photographs show how the appearance of cellulose fibres depends on the direction of polarization. Similar appearances have been found with very many natural and synthetic fibres. In spherulites and starch grains, two arms of a polarization cross appear, and rotate with the polarizer. Such effects are best observed when the object is mounted in a medium of refractive index fairly close to the maximum or minimum refractive index exhibited by the object, when parts of the image may be made almost invisible by a suitable setting of the polarizer. If this condition does not obtain, the relative intensity variation (that is, contrast) may be too slight to detect. If the refractive index of the immersion medium is intermediate between the maximum and minimum indices of the object, the appearance of the latter alternates between dark and bright phase contrast. This effect must be distinguished from a reversal of positive phase contrast which occurs with birefringent objects producing more than a critical phase difference, depending on the absorption of the phase plate.

It has been shown[1] that even in unfavourable conditions phase contrast is an exceptionally sensitive method of micro-refractometry, and phase differences of the order of $\lambda/100$ are not difficult to detect. In principle, the sensitivity could be very considerably increased by using heavily absorbing phase plates[2,3]. It therefore appears possible that this method could be used for detecting extremely weak birefringence in biological objects, of an order similar to that described recently by Swann and Mitchison in their remarkable improvement of polarizing microscope technique[4]. The new method has the advantage that it is possible to observe the whole field of view simultaneously, and thus to see the exact relationship between birefringent and non-birefringent areas, whereas the polarizing microscope selects only the birefringent areas. On the other hand, the immersion medium must be carefully selected, and it is not always possible to use the method for living objects in aqueous media. The phase difference as measured with the polarizing microscope is, of course, independent of immersion medium (in the absence of form birefringence). It may be objected that if the phase-contrast method is to be used for the measurement, as opposed to the detection, of birefringence, inaccuracy will be introduced due to the use of relatively wide illuminating cones. The error is not likely to be large for the type of object usually observed by phase-contrast microscopy, and, if necessary, a phase plate of low angular aperture can be used.

Very striking effects were found with interference microscopy. In the case of certain liquid crystals, areas containing sharp interference fringes alternated with quite large clear areas completely devoid of fringes when monochromatic unpolarized light was used. When a polarizer was introduced, the fringes extended into the clear areas, and on rotating the polarizer by 90° a dark fringe was replaced by a bright one. This provides an interesting illustration of the fact that a birefringent crystal actually resolves light into two components, and also that in such an object the contrast may be zero unless



Phase-contrast photographs of paper fibres mounted in Canada balsam. Cooke positive phase-contrast objective, N.A. 0·65, magnification × 500

1, Single polarizer inserted; horizontal fibre almost invisible; 2, polarizer rotated 90°; vertical fibre almost invisible; 3, unpolarized light; both fibres visible, but contrast of each intermediate between Figs. 1 and 2 polarized light is used. The moral is that in using any variety of 'phase-contrast' method, a polarizer should always be available as very considerable improvements in contrast may be revealed, as well as the presence of birefringence. It would, incidentally, be interesting to study the changes in the hologram[5] of a birefringent object illuminated by polarized light as the plane of polarization is varied. Dyson[6] has shown that his interferometer microscope[7] can be used for the measurement of phase differences corresponding to about one-fortieth of a fringe. The detection sensitivity is probably much greater. When unfiltered mercury-arc light is used, delicate colour changes can be observed in birefringent objects as the polarizer is rotated. With some types of interference microscopy it is possible to observe objects producing phase changes of several wave-lengths. In such cases birefringence can be measured by counting the change in the number of fringes across the object. This is not normally possible in phase-contrast microscopy, since phase changes differing by a whole number of wave-lengths cannot be easily distinguished.

Some caution is necessary in using binocular microscopes and eyepiece camera attachments. These may incorporate semi-reflecting beam splitters which introduce a moderate degree of polarization. In many binocular microscopes the plane of polarization differs by 90° in the two eyepieces. Thus, under suitable conditions, very different images may be seen in each eyepiece, even when no other polarizer is deliberately introduced.

The results obtained with crystals, fibres and biological materials will be described in detail elsewhere.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society.

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Jan. 25.

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Electron Microscope Studies of Human Breast Cancer

While observing the presence of characteristic particles in the milks and breast tumours of certain high-breast-cancer strains of mice[1,2] and establishing the relationship between these particles and Bittner's milk factor[3,4], we have been applying the same procedures to the study of comparable human material. A preliminary report was presented to the Pathological Society of Great Britain and Ireland at Oxford in July 1949.

In the summer of 1948, Dr. Edith Paterson, of the Christie Hospital and Holt Radium Institute, Manchester, kindly supplied us with colostrum from a pregnant woman suffering from cancer of the breast. Two months later we received a further sample taken from this patient 27 hr. after parturition. Adopting the technique previously described for the preparation of extracts from mouse tissues[1,2], the presence of many spherical particles in both samples was observed. In the electron microscope these particles were similar in appearance to those associated with the Bittner milk factor in high-cancer-strain mice, though probably on the whole slightly larger.

Since this date, the milks of two other similar cases have been studied with comparable results; and in the milk from another woman suffering from a cancer of the breast which had developed after she had given birth to a child, again similar particles were found, though fewer in number.

In addition, extracts of eleven human breast cancers have been examined and in all of them we have found particles comparable with those in the milks from human cancer cases. Also, out of twelve milks from apparently healthy women, eleven presented similar particles in varying numbers. The results are summarized in the accompanying table.

Presence of particles	Breast tumour	Cancer milk	Normal milk
++	4	3	1
+	3	0	4
±	4	1	6
−	0	0	1
Total samples examined	11	4	12

++, numerous particles; +, less numerous particles; ±, only occasional particles; −, particles absent.

A comment is necessary: we have observed that the human breast tumours which contained few or very few particles could, in the main, be classified microscopically as scirrhous in type: they were tough to the knife and extremely difficult to mince satisfactorily, even with the *MSE* blender. When observed in ordinary microscopical sections, there were fewer tumour cells present than in the softer, more fleshy type of tumours, which have invariably, so far in our experience, yielded the greatest numbers of particles (Fig. 1). These two characteristics of the scirrhous tumours may affect adversely the yield of particles in our preparations, in that the mincing is necessarily incomplete and there are fewer tumour cells in any case.

In general, the extracts of human breast tumours and of the milks from women with breast cancer (Fig. 2) did not contain as many particles as did the similar extracts from the high-breast-cancer-strain mice in our earlier studies. But if some allowance be made for the special characters of the scirrhous tumours, the impression we have gained from this obviously limited experience is that there are more particles in the tumours and milks from cancer patients than in the milks from apparently healthy women.

Thus we are faced with the fact that particles related in size and appearance to those observed in tumours and milks of high-breast-cancer-strain mice are detectable, often in high numbers, in (1) human breast tumours, (2) milks from women suffering from cancer, and (3) some milks from apparently healthy women.

Gross, Gessler and McCarty[5] report the presence of particles visible in the electron microscope in the milks of female relatives of breast-cancer patients, and in some of the milks of nursing, healthy women. While the range of sizes of their particles is in general larger than ours, this may be accounted for by their somewhat different extraction technique.

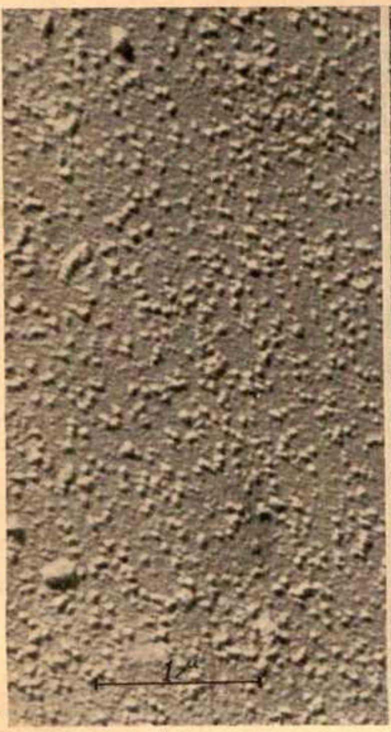

Fig. 1

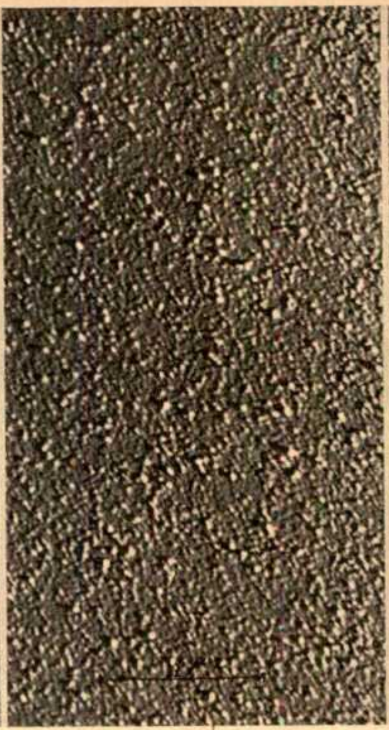

Fig. 2

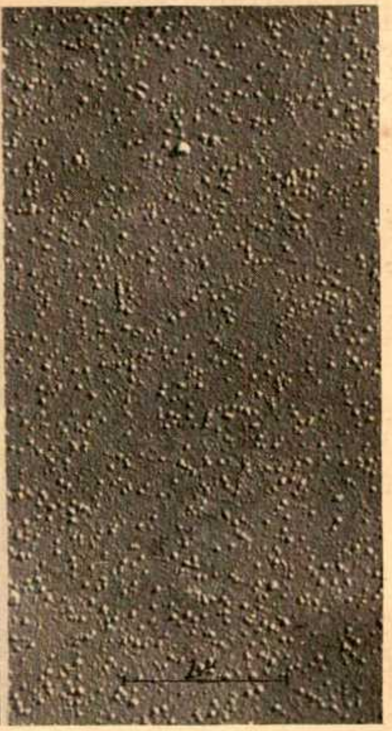

Fig. 3

Fig. 1. Human breast carcinoma; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

Fig. 2. Human milk from a woman with a breast carcinoma; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

Fig. 3. Human milk from an apparently healthy woman; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

It is the presence of particles, similar to those in human breast cancers, in the milks of women who are apparently healthy, which must make for great caution in interpreting these results, especially in view of the one normal milk (Fig. 3) which contained a large number of particles; though the subsequent history of this case is unknown.

At present it is not possible to offer any interpretation of the particles observed in the three classes of human material; neither is it known what connexion, if any, they may have with malignant disease of the breast in man, or with the particles associated with the milk agent in high-breast-cancer-strain mice.

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Thinning-down Effect in Nuclear Photographic Tracks

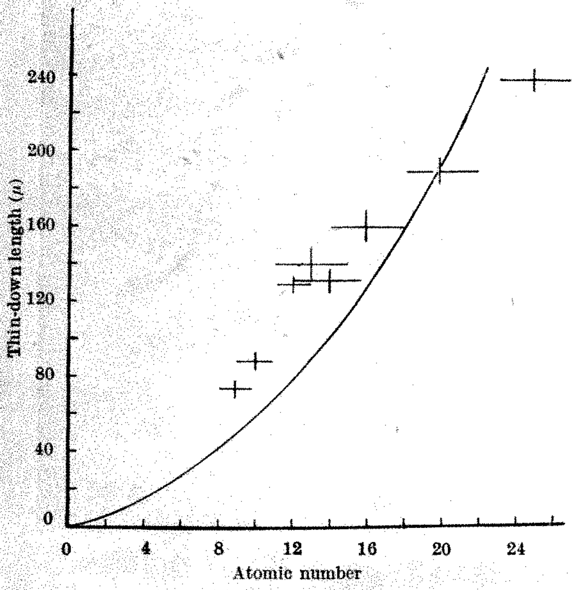
IT is well known that a heavy nuclear fragment begins to capture its orbital electrons when its velocity slows down below a certain limit. Consequently, its track observed in photographic emulsion shows 'thinning-down' near the end of its range. The length L of this thinning-down depends on the nature of the nucleus. Assuming Bohr's model, Freier *et al.*[1] have carried out an approximate calculation of L as a function of the atomic number of the nucleus; their results are reproduced in the accompanying graph (solid line). It will be seen that the length L in microns can be expressed by an approximate formula:

$$L \simeq \tfrac{1}{2}.Z^2.$$

Experimentally, an accurate measurement of the length of thinning-down is rather difficult. However, we have observed[2] that along this part of the track, the cross-section of the track decreases linearly with the range. This enables us to determine the length L by the following method: using drawings made with the projection microscope (magnification 2,200), the diameter d of the track is measured along the thinned-down part for every 20 microns of range; the graph of d^2 as a function of the range R gives the ratio:

$$\frac{d^2}{R} = \frac{d_0^2}{L},$$

where d_0 is the diameter of the track before it thins down; d_0 remains constant over a certain extent of the range, and can therefore be determined with accuracy. The above relation then gives the thin-down length L, the accuracy of the method being about 10 per cent.



We have measured, in collaboration with D. Morellet, some ten tracks of heavy primary nuclei (photographic emulsion, Ilford $G5$). The results are shown in the figure by crosses. The atomic number Z was estimated by the δ-ray method.

The experimental points do not fit the curve of Freier *et al.* For the nuclei of moderate atomic number Z, the length of thinned-down track L as measured is greater than that deduced from Bohr's model. This seems to suggest that for such nuclei ($Z < 20$) the thinning-down begins with the capture of first electrons, and the capture process starts probably at a velocity greater than the limit assumed by Bohr's theory.

If a power law is assumed to represent the approximate value of the thin-down length: $L \simeq a.Z^n$, we find from our results that the exponent is near unity. As pointed out by Perkins[4], the linear variation of L with Z can be accounted for if one admits that the nucleus captures its orbital electrons at velocity $2\pi e^2 z/n.h$ (z denotes the effective charge), where the quantum number n, instead of being equal to unity as assumed by Freier *et al.*, takes the value proportional to $Z^{1/3}$.

I wish to express my thanks to Prof. L. Leprince-Ringuet for the hospitality of his Laboratory; acknowledgment is also due to Dr. D. H. Perkins for interesting discussion on the subject.

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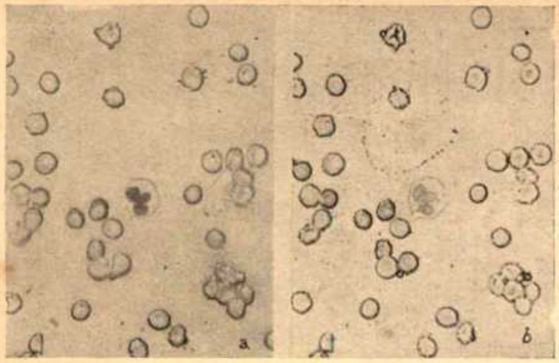
Use of Liquid Nuclear Research Emulsion in Track Autoradiography

IN a recent communication, King, Harris and Tkaczyk[1] described the use of liquid electron-sensitive emulsions in the autoradiography of biological specimens. We have used such emulsions for some time in investigations aiming at precise localization of radioactive isotopes in biological specimens by means of track autoradiography. In this communication we present some aspects of the technique which may be of interest to workers in this field.

The advantages of 'track' autoradiography over 'contrast' autoradiography in which the density of exposed grains in the emulsion is measured have been described by several investigators[2-4]. The main benefit is the possibility of quantitative estimation of the radioactive content of the specimen by counting the number of tracks emitted from it. In our work we were also concerned with the tracing of the origin of the track in order to determine the position of the radioactive atom with high precision, say, within a cell. The accuracy of such determination is limited by several sources of error: (*a*) the displacement of the emulsion relative to specimen during processing, due to lack of adhesion between them and to air locks, (*b*) distortion of emulsion due to lateral and vertical shrinkage, (*c*) chemical effects of the specimen on the emulsion and vice versa, giving rise to various artefacts[5], (*d*) osmotic pressure differences, which may cause the complete rupture of a delicate specimen.

The first of these errors can be reduced by using stripped emulsions[6] and completely eliminated by the use of liquid emulsions, which ensure an intimate contact between specimen and emulsion. This advantage of liquid emulsions was first pointed out by Belanger and Leblond[7]. On the other hand, the direct contact between specimen and emulsion aggravates the other sources of error, and we found that in order to eliminate these it is essential to separate the section from the emulsion by a protective layer. Such an impermeable layer prevents chemical action and the effects of osmotic pressure differences, and at the same time avoids shrinkage distortion by filling in the interstices and providing a plane surface on to which emulsion can be poured. In order not to reduce the length of the observable track and thus impair the accuracy of localization, the protective layer has to be as thin as possible. A medium has therefore to be used which can provide very thin and yet strong and impermeable layers. Other factors influencing the choice of the medium are: good adhesive properties to glass, section and emulsion, and chemical stability in the presence of developing reagents.

After trying out films of glass, mica, collodion, Canada balsam and distrene, we found that most satisfactory results are obtained by using 'Perspex'. The procedure is as follows: the specimen, for example, blood cells labelled with a radioactive isotope, is mounted on a slide and suitably stained. It is then covered with a 1 per cent solution of 'Perspex' in chloroform; the quantity of this solution has to be estimated in relation to the thickness of the section, so as to give a layer about one micron thick when dry. Next the section is dried over a period of several hours to prevent wrinkling of the surface. A trace of Canada balsam is smeared over the 'Perspex', to improve adhesion, and freshly melted Ilford $G.5$ emulsion is poured to the required



thickness. The whole is dried rapidly at room temperature by reducing the pressure to about 10 cm. mercury; this helps to force out air bubbles in the emulsion. After a suitable period of exposure the emulsion is processed in the usual way; but the plates have to be carefully washed, since traces of hypo increase the risk of peeling.

By using this method the cells appear to emerge from the treatment unharmed, and no distortion is observed either in the specimen or in the emulsion. Photomicrographs of a section obtained by this method, before and after coating with the *G.5* emulsion, are reproduced herewith; the section contained blood cells labelled with radioactive zinc. Zinc-65 is not very suitable for track autoradiography; but it was used in the study of a problem which will be described on another occasion. The erythrocytes and leucocyte, which are seen on the microphotograph together with an electron track (*b*), appear exactly the same as on the original section (*a*).

This work has been carried out with the aid of a grant from the Medical Research Council, to which we express our indebtedness.

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Excitation of Nitrogen in a Sodium Arc

SPECTROGRAMS have been obtained of a high current-density sodium arc obtained with a low-dispersion Hilger quartz spectrograph, in the region of 4000–2000 A. The cathode was a sodium pool in a 'Pyrex' glass tube of about 2 cm. diameter, and the anode was a hollow nickel-plated iron rod cooled by a stream of oil. The voltage supply for the high-current arc (2–6 amp.) was obtained from a 120-volt storage battery, and the low pressure inside the tube was maintained by a 'Cenco Hyvac' pump.

The first negative bands of nitrogen are brought out prominently along with the principal series lines of sodium at the higher current strengths used. Herman[1] found an increase in the intensity of the first negative system, after the break-up of a glow discharge in nitrogen, and ascribed it to the recombination of N_2^{++} ions with electrons. In the sodium arc containing an admixture of nitrogen, the excitation of nitrogen, presumably, arises from the collisions of the first kind between electrons and ground-state $X'\Sigma N_2$ molecules[2].

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De Haas - van Alphen Effect in Aluminium and Antimony

THE de Haas – van Alphen effect (periodic field dependence of magnetic susceptibility) has been found in aluminium and antimony single crystals at 4·2° K. and lower temperatures. The effect depends in a complicated way on the direction of the magnetic field, and there are complicated modulation effects similar to those previously found in other metals[1]. Typical values of the period at 15,000 gauss are 400 gauss in aluminium and 270 gauss in antimony; the amplitude in both metals increases by a factor of order 4 when the temperature is reduced from 4·2° K. to 1·5° K. Aluminium is the first metal of cubic symmetry in which the effect has been found.

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March 10.

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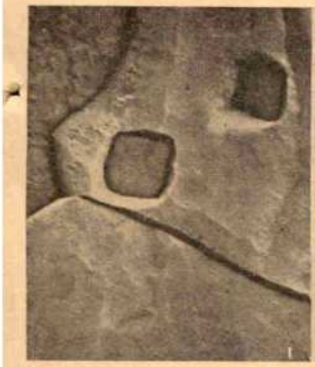
An Examination of Weld Metal by means of the Electron Microscope

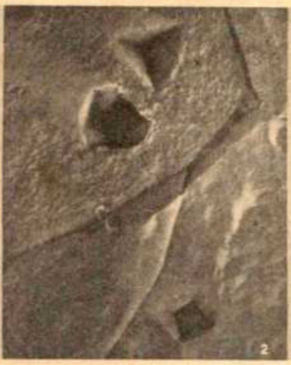
DURING a recent investigation into the cause of variation in the temperature of transition from rough to brittle behaviour of weld metal, the X-ray powder diffraction patterns of the non-metallic inclusions separated from different samples gave evidence of the presence of crystalline rhodonite (a manganese silicate belonging to the triclinic system) in weld metal of low transition temperature only, whereas chemical analysis indicated the same elemental composition of the inclusions in all cases.

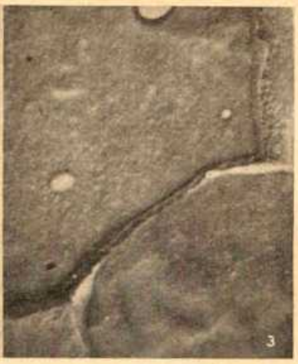
Examination by means of the optical microscope failed to confirm this observation, and as a result two samples of weld metal having high and low transition-temperatures were sent to this Laboratory for electron microscopic examination.

Negative 'Formvar' replicas, shadowed with chromium at an angle of 1 to 4, were made in the normal manner after the metals had been polished and etched. The etching consisted of a ten-minute treatment with a cold 5 per cent solution of hydrochloric acid (sp. gr. 1·18 aqueous) in ethanol, in which rhodonite is known to be soluble, followed by a light treatment with 2 per cent 'Nital' to bring out the normal microstructure. Several replicas were taken off each sample to ensure that any observed differences were truly representative.

Replicas taken from the low-transition-temperature metal revealed numerous well-defined pits, of which those seen in Figs. 1 and 2 (× *c.* 8,600) are typical.







These pits were randomly distributed throughout the replica specimens, and can probably be attributed to rhodonite inclusions in the sample. Only a very few isolated pits of similar appearance could be found among the specimens prepared from the high-transition-temperature metal; but it was noticed that pronounced attack had occurred along a number of grain boundaries in which segregation appears to have taken place. This effect is typified in Fig. 3 (× *c.* 8,600), and could be explained by assuming the segregation of rhodonite in a fine amorphous form.

This work provides an example, rare in practice, in which the electron microscope can be used to advantage for the examination of non-metallic inclusions.

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An External Cathode Hard-Glass Geiger–Müller Tube

In the course of work on the development of Geiger–Müller counters in this laboratory, some interesting properties of a hard-glass external cathode ('Aquadag') counter have been observed. Argon–alcohol counters filled to a pressure of 10 cm. of mercury, having internal diameters of one inch, and using a 7-mil central tungsten wire, were found to have plateaux extending from 1,200 volts to more than 3,000 volts. The slope of these plateaux was generally found to be less than 0·4 per cent per 100 volts. It was noted that the size of the pulses obtained from these counters is reduced with enhanced rate of counting. This phenomenon results in an apparent upward shift of the threshold voltage with increased rate of counting. The slope and length of the plateau remain unaffected by incidence of strong radiation, and the shift in the threshold voltage can be nullified by using a preamplifier at the input of the scaler. The decrease in pulse size and the consequent increase of the threshold voltage are shown in Fig. 1.

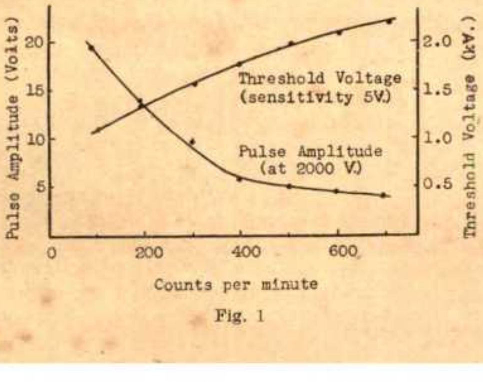

Fig. 1

The dead time of these counters has been found to be of the order of 3×10^{-4} sec., and compares not too unfavourably with that of 2×10^{-4} sec. generally reported for internal cathode counters[1]. With the use of a single tube preamplifier the counter efficiently recorded more than 4,000 counts per minute and showed a characteristic which has been plotted in Fig. 2.

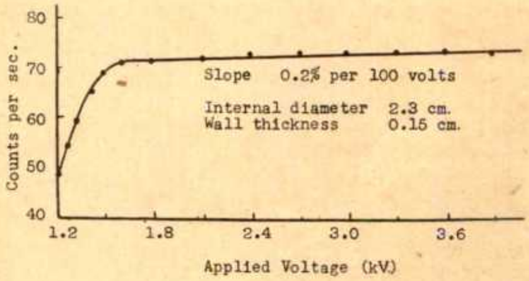

Fig. 2

A more complete account of this counter and a discussion of the results will shortly appear elsewhere.

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Nov. 16.

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Electrical and Optical Characteristics of D.C. Corona Discharge

English[1] has recently described the application of a photomultiplier—wide-band (100 Mc./s.) amplifier—oscilloscope technique to the study of the visible radiations emitted by the pre-onset streamers[2-4] in D.C. corona. Independently, similar techniques have been used in this laboratory during the past year for the study of positive point-to-plane corona (following earlier applications of similar techniques to spark channels[5,6] and impulse corona[7,8].).

The apparatus used included a conventional amplifier, having a rise time of 0·05 μsec., and an oscilloscope[9,10] using a 10,000-volt cathode-ray tube. The light pulses from pre-breakdown streamers in corona in air at atmospheric pressure are similar in shape but much longer (0·4 μsec. at 30 per cent of maximum pulse height) than those recorded by English (0·06 μsec.). Although the band-width of the apparatus

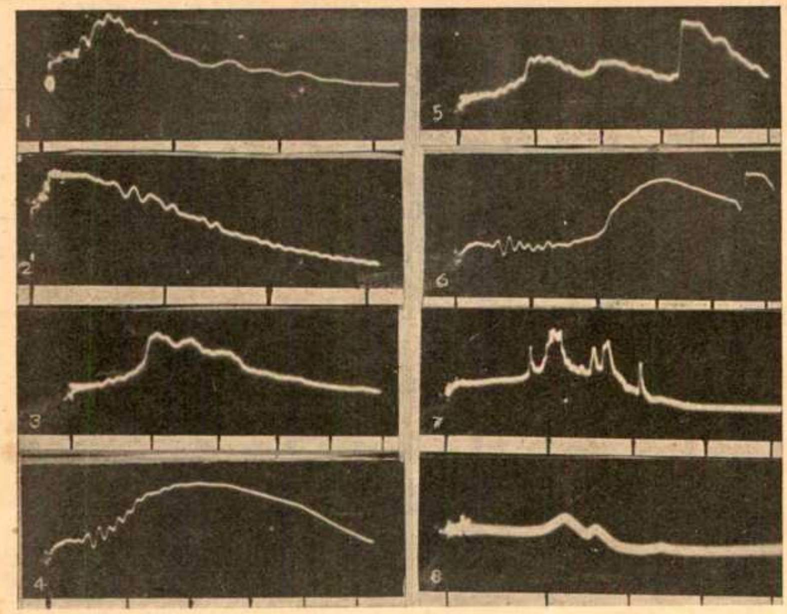

Fig. 1. Hydrogen light pulse. Calibration marks 0·5 μsec.
Fig. 2. Hydrogen current pulse. Calibration marks 1 μsec.
Fig. 3. Normal nitrogen light pulse. Calibration marks 1 μsec.
Fig. 4. Normal nitrogen current pulse
Fig. 5. Nitrogen light pulse showing the beginning of a second pulse.
Fig. 6. Nitrogen current pulse conditions similar to Fig. 5
Fig. 7. Argon light pulse. Calibration mark 5 μsec.
Fig. 8. Argon current pulse
Note. The ripples at about 0·6 μsec. on each electrical pulse are induced by the initiation of the hydrogen thyratron time-base

is much smaller than that used by English, it has, in the course of normal calibration work, recorded light pulses considerably shorter than those obtained from the air corona, and it appears unlikely that the discrepancy is due to instrumental deficiencies. Observations have been made both on pre-breakdown and pre-onset streamers, and the effect on pulse duration of circuit resistance, external irradiation and point radius has been found to be negligible. It is proposed next to construct an amplifier of greater band-width, of the order of 100 Mc./s.

Observations have been made on argon, oxygen, hydrogen and nitrogen, and in all cases except oxygen the pulses are so long that they are affected by amplifier band-width to an even lesser degree than the air pulses. The oscillograms reproduced herewith show the light pulses from the whole discharge; experiments relating to different parts of the discharge will be described in a later publication.

Brief descriptions are given of the records obtained for discharges in several gases at atmospheric pressure for a point radius of 0·09 mm., a gap-length of 5–8 cm., a 22,000-ohm resistance in series with the point and a measuring resistance of 20–60 ohms between the plane and earth.

Hydrogen. All the light pulses are similar to that shown in Fig. 1, having a duration of about 1 μsec. with a time of rise of about 0·25 μsec. The current-pulse induced at the plane is about 3 μsec. long, the time of rise not being recorded (Fig. 2).

Nitrogen. A typical light pulse (Fig. 3) is about 5·5 μsec. long with an initial rise to about 30 per cent of maximum amplitude in about 0·15 μsec. followed by a slower (1 μsec.) rise to the peak value. The current pulse (Fig. 4) shows an initial plateau about 1·0 μsec. long, the overall duration being about 5·5 μsec. The pulses vary considerably in shape; sometimes a second pulse, with a very short time of rise, follows closely on the tail of the first pulse, as in Figs. 5 and 6. The long pulse durations are associated with long streamers. The addition of small quantities of air shortens the pulses very considerably.

Argon. Streamers and light pulses are again long; the latter (see Fig. 7) are about 15 μsec. in duration and show a 1·0-μsec. rise followed by a 2·5-μsec. plateau and finally an erratic region which probably results from a filamentary discharge associated with, but distinct from, the streamers. This discharge is probably closely related to the glow described by Loeb[11] for D.C. corona and the impulse discharges described by various authors[8,12–16]. It is particularly strong in argon. The induced current pulses are similar in duration but do not show this erratic region.

Oxygen. Detailed results were not obtained; but the light pulse is considerably shorter than in air.

It is hoped to publish details of this work elsewhere.

One of us (H. M. G.) wishes to acknowledge generous financial assistance from the Electrical Research Association.

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A Strange Feature of Einstein's most Recent Generalized Field Theory

Einstein and Straus[1] developed a unified field theory in which the field variables consist of sixteen elements $g_{\mu\nu}$ $(\mu, \nu = 1, 2, 3, 4)$ of a non-symmetric tensor connected by a number of field equations. Schrödinger[2] also propounded a similar theory in which the field equations are nearly the same except that they contain additional terms involving a parameter λ, which takes a role analogous to that of the cosmological constant. Einstein's field equations will follow from Schrödinger's equation if we put $\lambda = 0$. Though there exists at present some confusion regarding the interpretation of the field variables, yet the most plausible and apparently most natural interpretation is to take the symmetric part of the tensor as the metric and the antisymmetric part as the electromagnetic tensor The solution of Einstein's field equation for the case

$$g_{11} = -\alpha(r), g_{22} = -r^2, g_{33} = -r^2\sin^2\theta, g_{44} = \nu(r), \quad g_{14} = -g_{41} = w(r),$$

can be obtained by writing $\lambda = 0$ for corresponding solutions of Schrodinger's field equations obtained by Papapetrou[3], and will be as follows

$$\left.\begin{aligned} \frac{1}{\alpha} &= 1 - \frac{2m}{r} \\ \nu &= \left(1 + \frac{e^2}{r^4}\right)\left(1 - \frac{2m}{r}\right) \\ w &= \frac{e}{r^2} \end{aligned}\right\} \qquad (1)$$

It is very natural to interpret m as mass and e as charge in this case

Now, Einstein[4] has recently changed his field equations again, which for the above case adds an additional equation,

$$2\frac{d}{dr}\left(\frac{w}{r\alpha}\right) + 6\frac{w}{r^2\alpha} = 0, \qquad (2)$$

over and above those which lead to (1) (The left-hand side of (2) was obtained by Papapetrou, who, it seems to me, made a numerical error in calculating it This, however, did not affect the final result, as the expression did not enter the final equations I am indebted to my father, Dr B B Banerji, for checking my calculations in this connexion) The consistency of (2) with the set which leads to (1) can be tested by substituting (1) in (2) This gives

$$-4\frac{e}{r^3}\left(\frac{1}{r} - \frac{2m}{r^2}\right) + \frac{2e}{r^2}\left(-\frac{1}{r^2} + \frac{4m}{r^3}\right) + 6\frac{e}{r^2}\left(\frac{1}{r^2} - \frac{2m}{r^3}\right) = 0,$$

which is satisfied only if either $e = 0$ or $m = 0$ This shows a strange feature of the recent field equations of Einstein, namely, that with the very natural interpretation of e and m suggested above, the existence of an isolated charged mass is excluded, whereas isolated massless charge (and certainly also chargeless mass) can exist

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A Unit of Wave-Number

WAVE-NUMBERS are more convenient than wave-lengths, not only in absorption and the dispersion of a prism[1], but also in atomic spectra, hyperfine structure and in the theory of resolution[2]

The objection to 'cm $^{-1}$' is, however, less the size of the unit than the inconvenience, not to say obscurity, of the multiples and sub-multiples '10^{-2} cm $^{-1}$' is doubtless correctly written 'm $^{-1}$', but few would use the synonym Call 'cm $^{-1}$' by some new name, such as 'Rydberg', however, and the difficulty disappears Absorption can be conveniently recorded in 'kilo-rydbergs' or 'kR', and hyperfine intervals in 'mR'

The name 'Rydberg' was suggested to me many years ago by Prof H Dingle Wave-numbers were, I believe, introduced by Johnstone Stoney, but first widely used by Rydberg in his famous formula

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March 8

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Human Immersion and Survival in Cold Water

IN examining the problem of survival of men immersed in cold Arctic waters, it is clear that the rate of cooling of the body will be of signal importance, and Glaser[1] has recently directed attention to the fact that heat losses from the human body immersed in cold water can be balanced, and the temperature of the deep tissues maintained, by exercise In addition, however, survival may well depend very significantly on the maintenance of some degree of *manual dexterity* for clambering on to rafts, wreckage, etc

Recent studies by one of us (C W) in the Arctic have shown that when the rate of heat production (due to exercise) not merely balances but even exceeds the loss, the temperature of the deep tissues (as measured in the rectum) rises, and this then influences very markedly the surface temperature of hands and feet[2] Thus, when men were exposed at rest in relatively light winter clothing on the flight-deck of an aircraft carrier in the Arctic, the surface temperature of the hands occasionally fell below 10° C, so that they were useless for fine manipulations The deep tissues cooled more slowly At this stage, mild exercise (150 kgm cal /m ^{2}/hr) caused the temperature of the deep tissues to rise soon after exercise began, and control-levels were regained at approximately one hour from the commencement of exercise Hands and feet continued to cool for the first three-quarters of an hour of exercise and then warmed abruptly, reaching levels which were often higher than those observed at the beginning of the experiment In the particular exercise employed (step-climbing), most of the additional heat is produced in the lower limbs, hence the rise in temperature of the hands is probably due to a reflex mechanism and not to local heat production in the muscles of the upper limbs

Such rewarming of hands which had previously cooled was so striking as to suggest that the cooling of bare hands might be more than compensated by an outflow of heat from the deep tissues generated as the result of severe exercise To test this probability, volunteers ran about the flight-deck in severe cold, with air temperatures as low as − 10° C and wind-velocities up to 18 knots, for two periods of ten minutes each, at a rate of approximately 7 m p h In the first period of exercise the men wore heavy body clothing but the hands were bare, in the second period, which followed immediately on the first, only shorts, vest and plimsolls were worn After the first bout of exercise, the temperature of the deep tissues rose to 102° F and the surface temperature of the fingers rose also, in some instances above 30° C After the second bout, the temperature of the deep tissues was relatively unaltered, and although the temperature of the fingers fell somewhat, they were rarely below 20° C Such temperatures are quite comfortable and allow of fine manual manipulations. However, the areas which are relatively poorly supplied with vasomotor nerves (nose, cheeks, ears, outer arm and forearm) did become frozen during the second bout of work In one instance, cooling of the forearm was so great that temporary paresis of the extensor muscles occurred However, the warming of the fingers associated with a raised body temperature permitted the use of the hands for fairly complex tasks such as buttoning a coat Cooling of muscle masses beneath areas of skin which are relatively poorly supplied with vasomotor nerves will clearly limit the length of time during which men immersed in cold and wet clothing will be able to use the upper limbs for swimming

The manner in which these physiological mechanisms operate may be appreciated more readily in terms of a simple physical model[3] of the various physical and physiological factors involved In our model, deep tissues and superficial tissues are regarded as relatively independent in their thermal behaviour[4,5] They are, therefore, represented by separate heat capacities which are joined by a variable 'average' heat conductance representing the ability of the body to vary the rate of blood-flow between the deep and superficial tissues and also within the superficial tissues. The control channels of the rate of heat-flow in this conductance are very analogous to 'servo-mechanisms', now familiar in engineering They are very sensitive to change in temperature of the deep tissues and considerably less to changes in temperature of the superficial tissues[3]

The model brings out clearly that the relatively slower rate of cooling of the deep tissues in a cold environment compared with the superficial tissues is due to an increase in the average resistance to heat-flow from the deep to the superficial tissues, and therefore to a greater proportional loss of heat from the superficial tissues Such a sudden restriction in the rate of heat-flow from the deep tissues may, in fact, in the first few minutes of exposure to cold, cause a paradoxical *rise* in temperature of the deep tissues, because the rate of heat production continues at much the same rate The rate of cooling of the superficial tissues has a relatively well-defined time-constant given by the product of their heat capacity and the thermal conductance by radiation and convection from the skin to the surroundings The relatively independent behaviour of the two heat capacities is well demonstrated during exercise in cold During the first three-quarters of an hour of exercise, the hands and feet continue to cool at the same rate as before Only when the temperature of the deep tissues is raised above control-levels does the resistance to heat-flow between the deep and superficial tissues decrease This then occurs suddenly, and the abrupt increase in heat-flow from the deep tissues is manifested in a rapid rise in the temperatures of hands and feet These two areas will, of course, demonstrate these effects more markedly than other areas of the human body as they are relatively rich in vasomotor nerves, the control mechanism which varies the rate of blood-flow in the peripheral vessels Calculations of the rate of cooling of the human body immersed in cold water should, in general, clearly take account of the relatively independent behaviour of these two heat capacities

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Evolutionary Importance of the South African 'Man-apes'

In the past, the discovery of any man-like fossil has signalled the beginning of extended and heated controversy After reading numerous recent publications on the South African 'man-apes', we have come to feel that history is repeating itself The great importance of this remarkable series of fossils is being obscured by technical argument over minor points and by the creation of genera, and even subfamilies of doubtful utility The present controversies over the South African fossils started before the discovery of many of the best preserved and most critical specimens, and a general statement of opinion now may help to orientate discussion when these latest finds are described in detail The basic ideas expressed here are not new, but the emphasis is perhaps different

The human ilium is a very distinctive, highly specialized bone, which is an essential part of the complex that makes possible efficient bipedal locomotion Among all mammals, the human ilium is approximated *only* in the South African 'man-apes' If the pelves only of these forms had been discovered they would surely have been attributed to man, and possibly even to the genus *Homo*. But the skulls associated with these pelves have small cranial capacities Thus, the great evolutionary importance of the 'man-apes' is that they show the *initial* division between ape and man to be a locomotor adaptation This fundamentally alters certain traditional theories of the origin of man and is in accord with Edinger's discoveries of the course of brain evolution in other mammals It has long been recognized that different parts of the body may evolve at different rates, although it seems to have been particularly difficult for many to apply this idea to man, the conception that all parts should evolve at comparable rates has been one of the main reasons for the refusal to accept unusual associations in the case of many human fossils

Since it now appears from the South African fossils that the rates of evolution of different parts of the body have been so different, comparisons of arboreal ape, 'man-ape' and man that are based on different parts of the skeleton will give quite different results For example, the humerus is very similar in ape, 'man-ape' and man If it is accepted that the human line became distinct from that of the arboreal apes primarily because of the bipedal adaptation, and that evolution proceeded at very different rates in other parts of the body, the original difference between ape and 'man-ape' may have been largely in the ilium. It is perfectly consistent to maintain that the 'man-apes' had separated from the arboreal apes and were on the way to becoming man, and yet, in the sum total of their anatomy, they were more like apes than men. It is the beginning of a new trend, a new adaptation, that is important, and not the sum of all anatomical details.

In the skull and dentition, there are features that definitely suggest evolution in the direction of man. These serve to strengthen and corroborate the evidence of the pelvis, but, taken by themselves, they would scarcely be sufficient to prove a close relationship. The fragments of the femur, likewise, are compatible with the idea that these forms were bipeds, but alone would not be sufficient to prove it. It is the ilium that shows the close approximation to man, and also indicates upright, bipedal locomotion. Even if the teeth were more like those of apes than they are, the main interpretation and significance of these forms would not be altered.

Whether the South African 'man-apes' were direct ancestors of man or collateral cousins depends on distribution and dating. It is quite possible that such forms ranged throughout the Old World tropics (*Meganthropus* of Java may well be closely related), and that evolution was proceeding over wide areas, rather than in one restricted region; but the dating of these fossils is uncertain.

So far as taxonomy is concerned, if the basic adaptation separating the human line from the ape line is bipedal locomotion, then the easiest way to express the facts is to place the 'man-apes' in the family Hominidæ. The family might conveniently be divided into two genera, *Australopithecus* and *Homo*. But the main evolutionary significance of the 'man-apes' is independent of the names ultimately applied. These fossils exhibit an unanticipated combination of features, illuminating the problem of the evolutionary transition from ape to man. Our gratitude is due to their discoverers, Dr. R. Broom, Prof. R. A. Dart and Mr. J. T. Robinson.

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Experiments on the Cause of Dorsiventrality in Leaves

IN flowering plants, a leaf primordium may be initially centric in shape[1]; but on further growth it becomes dorsiventral, a phenomenon of which the mechanism is but little understood. Results from experimental treatments of the shoot apex of the potato, *Solanum tuberosum*, shed new light on this phenomenon. The leaves arise in spiral sequence, with an average divergence angle of 138°. Primordia visible at the time of the operation will be called P_1 and P_2; P_1 being the younger. The first leaf to arise after the operation, but initially invisible, will be called I_1.

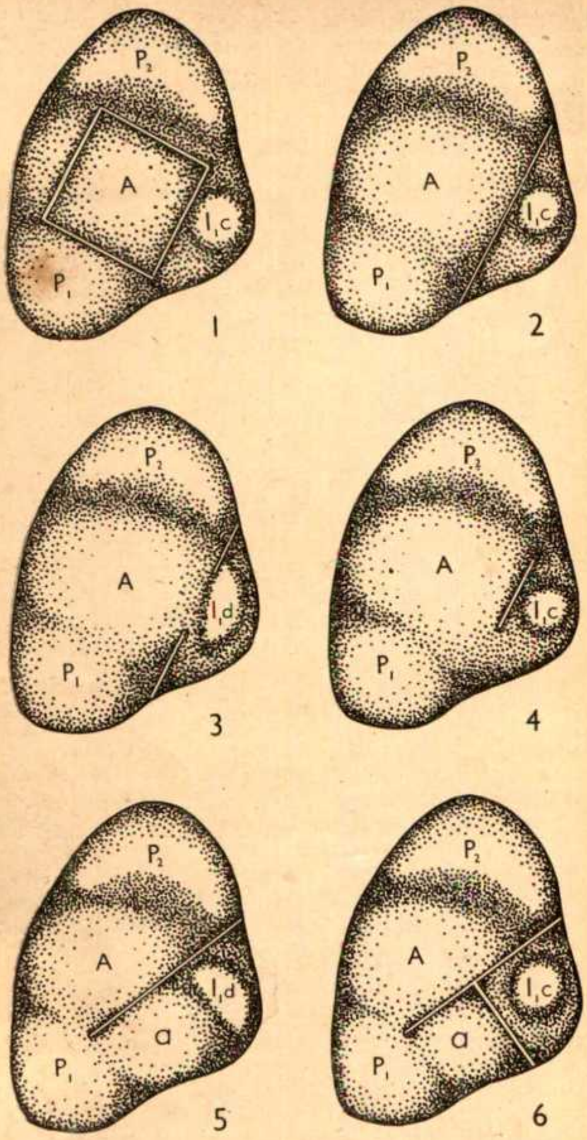
When the apical meristem of *Solanum* is isolated from the adjacent leaf primordia by four vertical incisions, a new leaf may arise on the meristem outside the cuts and it is sometimes centric. These centric organs occupy the I_1 position and are particularly interesting in view of recent experiments on the fern *Dryopteris aristata* reported by Wardlaw[2], who obtained solenostelic buds in positions normally occupied by leaves, when these were isolated from the apex by small tangential cuts. He considers that primordia of leaves and buds in *Dryopteris* are histologically identical. A leaf primordium develops under conditions where the growth-rate is greatest on the abaxial side, and where the adaxial side is probably subjected to inhibitive effects proceeding from the shoot apex; hence its dorsiventral symmetry. But buds, which typically develop on subapical or mature regions and thus may not be subjected to these unevenly distributed influences, are radially symmetrical.

As a result of various experimental treatments of the apex of *Solanum*, dorsiventral leaves have been observed to arise with an abnormal orientation to the main apex, but always with the adaxial face turned towards a newly formed apex. Dorsiventrality is apparently due to a basipetal inhibiting effect proceeding from the apical meristem. Surgical operations have been devised to test this hypothesis more fully. Six of these are shown in Figs. 1–6. When the apical meristem is isolated by four vertical cuts (Fig. 1), I_1 often develops centrically. The position of the cuts has a considerable effect on the development of I_1. When a cut is made close to the presumptive position of I_1, a centric organ develops; but if the cuts are close to the apex, a dorsiventral leaf is formed.

Evidence relating to the factors determining dorsiventrality was obtained by performing the operations shown in Figs. 2–4. When the I_1 position is isolated by a cut extending across the apex, from the edge of P_1 to the edge of P_2, a centric organ is formed (Fig. 2). When I_1 is isolated from lateral influences arising in or near P_1 and P_2, but when a direct path to the apex still remains, a dorsiventral leaf is formed (Fig. 3). If, however, I_1 is isolated from the apex by a small cut which does not extend to the margins, the primordium develops centrically (Fig. 4). By varying the size of this cut it is possible to alter the shape of I_1. If only a very small cut is made, a dorsiventral leaf is formed; if the cut is slightly larger, the leaf is at first nearly centric, but later develops a narrow lamina.

The most convincing evidence in support of the hypothesis was obtained by making cuts of the type shown in Figs. 5 and 6. Ball[3] has shown that when the apical meristem is divided, the lateral segments form new apices; these give rise to leaf primordia and grow as normal shoots. When the I_1 position is isolated and the apex unequally divided by a cut extending from the edge of P_2 to the mid-point of P_1 (Fig. 5), a new shoot apex is often formed in the smaller segment ('*a*' in Fig. 5). When I_1 arises it is dorsiventral and orientated at right angles to the new apex (and deflected up to 25° from its normal direction). Additional proof of the apical control of dorsiventrality can be obtained by making a second cut at right angles (Fig. 6) midway between the P_1 and I_1 positions. In these experiments I_1 is centric.

The size and structure of the centric organs vary greatly. Some lose their meristematic activity at an early age and consist only of parenchyma. These have no vascular supply and cause no disruption of the stem vascular tissue. In the more elongated ones (which, however, do not become as long as the normal leaves) a protostelic vascular strand may reach almost to the tip, though in most cases it fades out below this point. In some specimens there is a more or less extensive solenostelic region near the base. The leaf-trace connects with the vascular system of the stem through a leaf gap which may be narrower



Figs. 1–6 illustrating diagrammatically the apex immediately after the operations described in the text. P_1 and P_2, the two youngest leaf primordia present at the time of the operation. I_1, the first leaf to appear after the operation (not drawn to the same scale). I_1c, centric organ developed in the I_1 position. I_1d, dorsiventral leaf developed in the I_1 position. A, main apex; a, induced apex

than usual. So far, no axillary buds have been found associated with these centric leaves.

The formation of centric organs instead of dorsiventral ones has been reported on several occasions. Versluys[4] observed that a centric bract often arose from the remainder of the apex after the formation of axillary flower primordia in the cherry. Lang[5] found that, by destroying the apical regions of the shoot of *Osmunda regalis*, organs which appeared to be centric leaves were frequently produced. These often bore lateral or terminal sporophytic buds, and sometimes the tip gave rise to a prothallus. M. and R. Snow[6] have described radially symmetrical organs on experimentally incised apices of *Epilobium hirsutum*; they attributed the form of these organs to the almost terminal position which they occupied. Wardlaw[7] obtained awl-shaped leaves with reduced vascular strands in *Onoclea sensibilis* grown under conditions of high humidity and low light intensity. This resulted in apical inactivation and a concomitant development of abnormal leaves. As a result of isolating very young leaf primordia of *Dryopteris* on plugs of pith, he was able to convert these into centric organs with a solenostelic vascular strand[8]. The growth of these organs was extremely limited. Results of this kind have previously been interpreted on a nutritional basis[7,8]; but it is apparent that in all the cases cited above, the production of centric organs is closely related to a cessation of apical growth, or to an elimination of its effects. The experimental results now reported support this conclusion.

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Wax Secretion in Insects

WHILE it is generally agreed that insects and their eggs conserve water by the use of specialized layers of wax[1–3], no clear explanation exists as to the mechanism of wax secretion.

In the cuticle of *Rhodnius*[1,4], and the egg of the red spider mite[5], the waxes are known to be secreted in a mobile, if not liquid, form; in these and many others, these waxes harden to a crystalline solid in a comparatively short time. The wax secreted by Gené's organ in ticks[6] becomes much less mobile soon after its application to eggs. In contrast, the cockroach is waterproofed by a grease which remains mobile throughout life[7].

It has recently been observed that a sample of grease extracted from cockroach cuticles and left exposed to the air at room temperature for three months becomes a hard white crystalline material. The grease has a melting point of approximately 34° C.; the final product, which is a wax, melts sharply at about 55° C. Samples of the original grease have been sealed in small tubes in oxygen and nitrogen, and kept in light or dark for three months without apparent change; the melting point does not alter by more than three or four degrees in these circumstances. On the other hand, after a sample of grease has been heated carefully in air or *in vacuo* at a temperature of about 100° C. for some minutes, its melting point rises by several degrees, and after an hour's heating, a hard white wax is obtained which melts at 55–60° C. This melting point is not affected by prolonged further heating.

It would seem that we can eliminate the possibility of oxidation or polymerization changes in such inert materials as these waxes[2], and conclude that they are secreted in a solvent which evaporates slowly. In the cockroach, the continual activity of the œnocytes[3] suggests that grease, or perhaps solvent, is being secreted continuously throughout life to replace loss. In other insects, the existence of a more volatile solvent, which evaporates rapidly after secretion, would explain the observed facts.

Work is now in progress to identify the volatile material in cockroach grease, and to examine the possibility of wax solvents being concerned in the secretion of waterproofing layers in other insects

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A Depressant Effect of Adrenaline on the Rat Diaphragm

IT is well known that adrenaline usually augments the contractions of striated and cardiac muscle, this is also true of the isolated phrenic nerve diaphragm preparation of the rat stimulated rhythmically, especially if it is depressed by excess potassium

Goffart and Brown[1], in 1947, reported a depressant action of adrenaline correlated with a low intramuscular potassium, and it has now been found that when the Krebs–Ringer solution in which the preparation is placed is modified to contain less than 2 5 mgm per cent calcium, adrenaline at a concentration of 1/10⁷–1/10⁸ produces a marked and rapid depression of the responses to electrical stimulation The depression is preceded by a brief potentiation and is followed by a slower spontaneous recovery, the whole response taking 15–30 min The extent of the depression produced varies somewhat as the initial contraction height, but its duration is never proportionately increased From similar experiments in Tyrode's solution, potassium ions appear to be essential for the recovery

The depression is not present in denervated muscle, but occurs in neuromuscular block brought about by curare and by complete absence of calcium

This observation is in accord with the observation of McDowall and McWhan[2] that blood vessels perfused with Ringer's solution deficient in calcium are dilated by adrenaline, and with those of many observers who have found that adrenaline may depress the perfused heart under similar conditions.

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Pyruvate Metabolism in *Saccharomyces cerevisiæ*

IT is generally assumed that *Saccharomyces cerevisiæ* (baker's yeast) can metabolize pyruvate (*a*) by simple decarboxylation, a reaction not requiring oxygen, catalysed by carboxylase[1], and (*b*) by oxidation, as described by Lieben[2] and Meyerhof[3], an oxygen-requiring reaction the precise mechanism of which is not known In this communication, experiments are briefly described which provide a general explanation of the mechanism of pyruvate aerobic oxidation by yeast and determine the role of carboxylase

Pure suspensions of starved, pressed baker's yeast have been used for the experiments General methods are the same as in a previous communication[4] The oxygen uptake and carbon dioxide evolution were measured by the Warburg direct method[5] Pyruvate was estimated with the Friedemann and Haugen[6] or the Straub[7] method, with consistent results All experiments have been carried out at *p*H 4 5, corresponding to the physiological hydrogen ion concentration of the medium for the growth of *S cerevisiæ*[8]

TABLE 1 EFFECT OF DICARBOXYLIC ACIDS AND CARBON DIOXIDE ON PYRUVATE CONSUMPTION

5 7 mgm yeast (weighed after drying at 100°) suspended in 2 0 ml 0 05 *M* buffer, in Warburg flasks with air, or air and 5 per cent carbon dioxide, in the gas space Potassium hydroxide in the central well of the flasks filled with air 60 μ*M* pyruvate added after 30 min equil Final *p*H, 4 5 The figures represent μ*M* pyruvate consumed after 90 min incubation, at 30°, and allow for the respective controls.

Medium	Atmosphere	
	Air	Air and 5% carbon dioxide
Phthalate	10 4	17 0
Succinate	17 0	16 4
Fumarate	18 7	17 9
l-Malate	18 0	18 3

Our results can be summarized as follow (1) At *p*H 4 5, living yeast cells consume pyruvate only in the presence of oxygen, as earlier reported by Smythe[9], notwithstanding the significant amount of carboxylase present in the cells, as proved by (*a*) the ability to ferment glucose, evolving carbon dioxide under strictly anaerobic conditions, and (*b*) the intense carboxylatic activity of the saline extracts obtained from the cells after drying (2) C_4-dicarboxylic acids stimulate the aerobic pyruvate consumption by the yeast cells (Table 1) It may be admitted that the effect of dicarboxylic acids is produced with about the same concentration activating pyruvate oxidation by the brain pyruvate oxidase[10] as the concentration of the acids inside the yeast cells is 5–10 times smaller than in the suspension medium[11] Dicarboxylic acids replace the stimulating effect of carbon dioxide on pyruvate consumption, earlier described by Brandt[12], and confirmed by our experiments This implies that the effect of carbon dioxide may be mediated through synthesis of a dicarboxylic acid (Wood and Werkman reaction[13]) (3) Dinitrophenols, some of which (for example, the 2,4-compound) dissociate oxidation from phosphorylation and interfere with oxidations where the substrate activation is apparently dependent on a phosphate exchange[14], inhibit intensely pyruvate oxidation and the corresponding carbon dioxide formation (Table 2) At *p*H 4 5 the pI_{50} ($-\log_{10}$ molarity inhibiting 50 per cent pyruvate consumption) is 4 50, 3 50 and 3 72 for 2,4-, 2,5- and 2,6-dinitro-

TABLE 2 EFFECT OF 2,4-DINITROPHENOL ON PYRUVATE OXIDATIVE DECARBOXYLATION

12 1 mgm (dry wt) yeast, suspended in 0 05 *M* phosphate with 52 0 μ*M* pyruvate *p*H 4 5 Air in the gas space The figures represent μ*M* oxygen or pyruvate consumed and carbon dioxide evolved after 90 min incubation, at 30°, and allow for the respective controls Relative inhibition in parentheses

Inhibitor	CO_2	O_2	Pyruvate
None	12 5	10 3	10 8
10^{-4} *M* 2,4-dinitrophenol	1 2 (90 4)	1 3 (87 4)	0 8 (92 6)

phenols, respectively The effect of dinitrophenols depends greatly on the *p*H of the yeast suspension medium and cannot be detected at *p*H 7 3 At about *p*H 6 0, 2,4- and 2,6-dinitrophenol (7 0–1 0 × 10^{-4} *M*) do not affect significantly the activity of a carboxylase preparation, purified according to Green *et al* [15], but 2,5-dinitrophenol (6 4 × 10^{-4} *M*) inhibits it to the extent of 61 5 per cent In the presence of pyruvate and dinitrophenol, at concentrations wholly or partially inhibiting pyruvate oxidation, no acetaldehyde accumulation can be detected, the oxidation of which by yeast is intensely inhibited by dinitrophenols[16] It must be pointed out that the same concentrations of dinitrophenol do not affect carbon dioxide formation during glucose fermentation (4) Thiol reagents like ethyl iodoacetate (4 2 × 10^{-4} *M*) or chloroacetophenone (6 0 × 10^{-4} *M*), which do not inhibit carboxylase, strongly inhibit pyruvate decarboxylation by the living yeast cells (5) Pyruvate oxidation is associated with orthophosphate uptake, which is inhibited by dinitrophenol (Table 3) in about the same degree as pyruvate consumption

TABLE 3 EFFECT OF 2,4-DINITROPHENOL ON ORTHOPHOSPHATE EXCHANGE ASSOCIATED WITH PYRUVATE OXIDATION

43 0 mgm (dry wt) yeast suspended in 12 0 ml 0 05 *M* phthalate with 205 *μM* pyruvate *p*H 4 5 Oxidation for 40 min , at 30° The figures represent *μM* pyruvate and orthophosphate (*μP*) consumed and allow for the respective controls Initial orthophosphate, 3 50 *μP*

Additions	Pyruvate	μP
Pyruvate	76 8	2 82
,, and 0·8 × 10^{-4} *M* 2,4-dinitrophenol	18 2	0 18

On the evidence already given, it may be concluded that (*a*) *S cerevisiæ* oxidizes aerobically *added* pyruvate by means of an enzymic mechanism similar to pyruvate oxidase from animal tissues, (*b*) carboxylase does not belong to this system, although it does decarboxylate pyruvate formed inside the yeast cell, and (*c*) carboxylase seems to be in a metabolic region of the yeast cell not accessible to the pyruvate or inhibitors present in the suspension medium The existence of these metabolic regions in the yeast cells has been recently reported by Conway *et al* [11]

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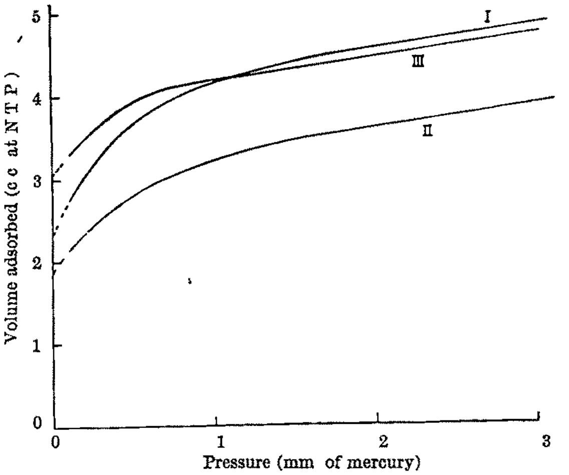
Influence of a Chemisorbed Film on Subsequent Physical Adsorption Processes on Solids

DESPITE the great amount of experimental work in the past twenty years on the physical adsorption of gases by solids, the effect of a chemisorbed film on the subsequent physical adsorption of other gases has never, to our knowledge, been thoroughly investigated However, occasional observations have been noted, particularly in connexion with the Brunauer–Emmett–Teller surface-area measurements[1], and the general conclusion has been that the presence of a chemisorbed film does not affect such measurements, provided that there is no blocking of capillaries, as might occur on a porous solid[2] The following observations may therefore be of interest

These experiments, the results of which are presented in the accompanying graph, were carried out originally in an endeavour to measure the surface area of a copper oxide catalyst[3] by the physical adsorption of krypton at liquid oxygen temperatures, using the standard adsorption technique All measurements were made on the same 7-gm sample of catalyst



Curve I, clean surface of copper oxide , curve II, after adsorbing carbon monoxide to saturation at room temperature, giving a coverage of approximately 20 per cent, that is, 1 5 c c of carbon monoxide , curve III, after addition of approximately 4 c c of oxygen to surface II, converting the carbon monoxide to a CO_2-surface complex (ref 3), excess of oxygen is present on the surface Curve III is also the isotherm for the surface after 3 8 c c of oxygen, only, has been adsorbed at room temperature, corresponding to about 100 per cent coverage

These results are completely reproducible, the chemisorbed gases being removed by evacuation of the catalyst at 180° C to give a clean surface on which the adsorptions can be repeated The isotherms shown are the mean of two or three independent runs in each case

The krypton adsorptions give good straight lines when plotted according to the Brunauer–Emmett–Teller equation, the average V_m values being I, 4 35 c c , II, 3 51 c c , III, 4 22 c c , in agreement, so far as can be judged, with the 'point *B*' values[1] Two isotherms were also obtained with butane at − 78° C , the V_m values being I, 2 30 c c , II, 1·86 c.c

The phenomenon is at present the subject of a more comprehensive investigation in this laboratory, and a full discussion will be published elsewhere However, we feel that a qualitative interpretation of the influence of a chemisorbed film may be based on the following lines

It is assumed that these isotherms represent the start of a multi-layer condensation process, that is, the 'S-shaped' isotherms of the Brunauer–Emmett–Teller theory Again, following the Brunauer–Emmett–Teller treatment, we assume an average heat of adsorption on the clean surface to be E_1 for the first layer and E_L for subsequent layers, where E_L is approximately, if not exactly, equal to the heat of liquefaction of the adsorbate Let the average heat of physical adsorption on the chemisorbed film be E'_1 for the first layer, and E_L for subsequent layers In general, $E'_1 \neq E_1$, but providing $E_1 > E_L$, then, though the isotherms for the clean and contaminated surfaces will not exactly correspond, nevertheless the point B and V_m values will be approximately the same We suggest that this is the case in curve III for chemisorbed oxygen and the CO_3-complex Indeed, the isotherms here indicate that $E'_1 > E_1$ at low coverages, a fact which lends itself to interesting speculation

On the other hand, if $E'_1 < E_L$, then effectively no condensation will occur, at low relative pressures, on that fraction of the surface which is covered with the chemisorbed film , and the isotherm and V_m value will correspond to the bare portion of the surface only This, we suggest, occurs in curve II, where approximately 20 per cent of the surface is covered with chemisorbed carbon monoxide and the decrease in adsorption of krypton (and butane) is of that magnitude

The question arises as to the likelihood of E'_1 being less than E_L in this case, that is, of the heat of adsorption of krypton on chemisorbed carbon monoxide being less than the heat of liquefaction of krypton It is, of course, fairly easy to show that the van der Waals attraction between an isolated 'gas-phase' carbon monoxide molecule and a krypton molecule would be less than that between two krypton molecules If we assume that on chemisorption the polarizability, 'characteristic energy' and dipole moment of the carbon monoxide molecule are not markedly increased, then it is quite probable that $E'_1 < E_L$ Conversely, if these isotherms are accepted as evidence that $E'_1 < E_L$, then it is possible to draw some qualitative inferences as to the nature of the chemisorbed state of carbon monoxide

It is obvious that these very simple observations do not in any way depend on the more quantitative aspects of the Brunauer–Emmett–Teller theory which have recently been questioned[4] Certain implications of the above treatment are being examined both theoretically and experimentally, and will be published in due course

We are indebted to Prof W. E Garner for much helpful discussion on this subject

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Association Reaction of Methyl Radicals

THE nature of the bimolecular radical reaction which terminates the chains in the high-temperature photodecomposition of acetaldehyde will only be shown by analysis Assuming the reaction

$$CH_3 + CH_3 \rightarrow C_2H_6,$$

the amount of ethane to be expected can be calculated by the graphical integration

$$\frac{k_1 R_0}{2K^2 p_0\{1-\exp(-\alpha p_0)\}^{1/2}} \int_{p_0}^{p_1} \frac{\{1-\exp(-\alpha p)\}^{1/2}}{p}\, dp \approx \frac{k_1}{\varphi}\left(1 - \sqrt{\frac{p_1}{p_0}}\right)$$

where p_0 mm acetaldehyde have been irradiated, decomposing at initial rate R_0, to a final acetaldehyde pressure p_1 mm The light absorbed is given by $I = 1-\exp(-\alpha p)$, K is the overall reaction constant, where $R = KpI^{1/2}$, φ is the overall quantum yield, and k_1 is the quantum yield of the primary process,

$$CH_3CHO \xrightarrow{h\nu} CH_3 + CHO$$

The amounts of ethane thus obtained are such that only mass spectrometry will detect and estimate them in the presence of considerable quantities of methane and carbon monoxide

Analyses have been carried out on the products of prolonged photolysis (up to 24 hr for at least 90 per cent decomposition) of 200 mm acetaldehyde at various temperatures and with $I_0 \approx 10^{-10}$ $Nh\nu$ cm $^{-3}$sec $^{-1}$, $\lambda = 2537$–3130 A Table 1 shows the results obtained (after removal of residual aldehyde)

Table 1

Temp ° C	Mole (per cent)				
	CO	CH_4	HCHO	H_2	C_2H_6
123 obs	49 6 50 4	43 5 42 4	0 2 0 2	2 9 3 1	3 9 3 9
calc	50 0	41 8	4 1		4 1
212 obs	49 8	44 7	0 2	3 3	2 1
calc	50 0	49 0	0 5		0 5
422 obs	49 9	48 7	<0 1	0 9	0 5
calc	50 0	50 0	<0 01		<0 01

Probable errors in analysis for formaldehyde, hydrogen and ethane are ± 0 2 mole per cent The presence of formaldehyde is thus not definitely established

Some preliminary analyses for ethane showed the same trend (see Table 2)

Table 2

Temp ° C	125	140	308
Ethane (obs)	2 7	2 7	1 1
,, (calc)	3 3	1 4	0 07

Some peaks of very low intensity at mass numbers 31, 40–46, 58, 60 indicated traces of other oxygenated compounds In particular, upper limits of 0 2 and 0 05 per cent respectively can be given for glyoxal and diacetyl

The presence of ethane is consistent with the assumed termination reaction , though the calculated figure is subject to some uncertainties, particularly in the value to be given to k_1, the quantum yield of the primary process Here we use $k_1 = 0$ 5 The formaldehyde and hydrogen probably arise from side reactions,

$$\begin{array}{l} CHO + CHO \rightarrow HCHO + CO \\ \qquad\qquad\quad \searrow H_2 + 2CO, \end{array}$$

the material balance requiring that $p_{C_2H_6} = p_{HCHO} + p_{H_2}$

If the ethane does arise from the reaction between methyls, this excludes the reaction

$$CH_3 + CHO \rightarrow CH_4 + CO$$

as the chain termination On the other hand, it does not exclude the alternative mechanism in which formyl radicals propagate the chain, when the reaction between methyl radicals would be the side reaction Nevertheless, the weight of evidence is for methyl radicals as chain carriers If that is the case, the above analysis suggests that the termination is, in fact,

$$CH_3 + CH_3 \rightarrow C_2H_6$$

This view is further substantiated by the agreement between the constants determined, by the sector method, for the termination reaction in the photolyses of acetaldehyde[1] and of mercury dimethyl[2] The observed frequency factors, of the same order as the collision frequency, do not, however, agree with the steric factor 5×10^{-3} found by Marcus and Steacie[3] for the same reaction

We have recently learned that Danby, Buchanan and Henderson[4] have carried out, independently, extensive mass spectrometric analyses on the products of the reaction in its initial stages and have reached the same conclusion about the chain-ending process

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Use of 95 per cent Ethyl Alcohol as a Solvent for Ultra-Violet Spectroscopy

IN connexion with a problem on the determination of the ultra-violet absorption spectra of organic molecules dissolved in 95 per cent ethyl alcohol[1], it was necessary to determine the suitability of the alcohol as a solvent in the region of 2000 A There is a report[2] that carefully purified 95 per cent ethyl alcohol[3] is suitable for the region of 2000 A , although no experimental results were given Observations in this region have been reported by MacLean, Jencks and Acree[4] for ordinary commercial 95 per cent ethanol, and they find that unpurified alcohol is completely opaque in this region

It seemed to be of interest, then, to determine the transmission of purified 95 per cent ethanol down to 2000 A The results are shown in Table 1 The percentage transmission of the alcohol was determined with the aid of a Beckman quartz spectrophotometer equipped with a Nestor hydrogen lamp The transmission of the alcohol at the various wave-lengths was measured against distilled water, and it was assumed that the transmission of the water in this region was 100 per cent Column *a* gives the results for the transmission of the untreated commercial alcohol , column *b* is for the alcohol after refluxing with dilute sulphuric acid and distillation[2], column *c* after treatment of the acid-treated alcohol with silver oxide and distillation Repetition of the purification procedure with this alcohol did not materially change the values reported in column *c*

Table 1

λ (A)	(*a*) % Transmission	(*b*) % Transmission	(*c*) % Transmission
2300	62	68 2	83 8
2250	54	59 2	76 5
2200	46	50	67 5
2150	36	40	57 5
2100	28 2	33 8	45 5
2060	17	18 5	29 2
2040	10 8	10 9	18 9
2020	5	5	9
2000			6

Pirlot[5] has recently described another method for the purification of alcohols for ultra-violet spectroscopy, consisting in treatment with iodine, removal of the iodine with zinc and then passage of an alkaline solution of the alcohol over a column of activated charcoal. The results for ethyl alcohol in the region of 2000 A. were not reported, but from the data for the transmission of methyl alcohol in this region, it would seem that the values for ethyl alcohol treated in this fashion would be similar to those reported now

Table 2

λ (A)	(*a*) % Transmission	(*b*) % Transmission
2300	75 5	79 8
2250	68 0	70 8
2200	60	62 3
2150	50 8	54 0
2100	30 0	43 0
2050	9 0	18 2
2020		9 1
2000		3 5

An investigation of the transmission of commercial absolute alcohol was also made The results are shown in Table 2 Column *a* shows the transmission for the untreated alcohol , column *b* shows the transmission after refluxing with dilute sulphuric acid, distillation and treatment of the distillate with silver oxide. The first and last 15 per cent of each distillate was discarded

On the assumption that the solvent should transmit at least 50 per cent of the radiation[2] to be suitable at any particular wave-length, it would appear that even carefully purified 95 per cent ethanol is not a suitable solvent for work below 2100 A , and absolute alcohol is not suitable below 2120 A

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[4] MacLean, Jencks and Acree, *J Res Nat Bureau of Standards*, **34**, 271 (1945)

[5] Pirlot, *Bull Soc Roy Sci Liège* **18**, 115 (1949)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Saturday, April 21

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2 30 p m —Mr Haswell Alder, Mr S W Potts and Mr Arthur Walker "Mechanized Room and Pillar Mining—a General Appreciation of Developments in this Country"

Monday, April 23

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S W 7), at 5 p m —Prof Carl Troll "High Mountain Physiography and Plant Geography in Different Climatic Belts"

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Dr N W Pirie, F R S "Concepts out of Context—The Pied Pipers of Science"

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Discussion on "The Trend of Design of Television Receivers" (to be opened by Dr A J Biggs)

Tuesday, April 24

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S W 1), at 5 30 p m —Mr G A Maunsell "Some Unsolved Problems in Civil Engineering" (James Forrest Lecture)

CHEMICAL SOCIETY LEEDS SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Department of Chemistry, The University, Leeds), at 6 30 p m —Dr J Kenyon, F R S "The Use of Optically Active Compounds in the Study of Organic Reactions"

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St Mary's Parsonage, Manchester), at 6 30 p m —Mr Reginald Booth "Germany"

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London W 1), at 6 30 p m —Sir Frederic Bartlett, F R S "Human Control Systems"

Wednesday, April 25

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, in the Cambridge Hall, Municipal Buildings, Southport), at 10 a m —Discussion on "Composition and Scientific Control in the Manufacture of Ice-cream, Synthetic Cream and other Emulsified Food Products" (to be opened by Mr A L Bacharach)

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 10 a m amd 2 30 p m —"A Study of Drying" (Final Conference) *

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Sir Andrew Bryan "Safety in Mines" (Cadman Memorial Lecture)

GEOLOGICAL SOCIETY OF LONDON (at Burlington House Piccadilly, London, W 1), at 3 p m —Annual General Meeting, Prof O T Jones, F R S "The Drainage Systems of Wales and the Adjacent Regions" (Anniversary Address)

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 3 p m —Symposium on "Infra-Red Spectroscopy"

ASLIB (in the Lamont Room, National Book League, 7 Albemarle Street, London, W 1), at 4 p m —Annual General Meeting

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Mr D J Morgan and Mr W J Corlett "The Influence of Price in International Trade, a Study in Method"

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Inaugural Lecture by Prof F Brailsford "Magnetic Materials in Electrical Engineering, their Limitations and Improvement" *

UNIVERSITY OF LONDON (at King's College, Strand, London, W C 2), at 5 30 p m —M André Chevallier "The Use of Carrier Currents for Control Protection and Communication in Power Systems" * (Further Lectures on April 27, 30 and May 2)

BRITISH INSTITUTION OF RADIO ENGINEERS, WEST MIDLANDS SECTION (at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton), at 7 p m —Dr T Emmerson "Some Physical Principles used in Electronic Equipment"

Thursday, April 26

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 2 30 p m —Discussion on "Symbiosis involving Micro-organisms" (to be opened by Dr H G Thornton, F R S)

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 4 45 p m —Prof H A Krebs, F R S "Energy Transformations in Living Matter" * (Further Lectures on May 3, 10 and 17)

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Sir John Cockcroft, F R S "Modern Conceptions of the Ultimate Structure of Matter" (Forty-second Kelvin Lecture)

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m —Discussion on "The Calibration of Microphones by the Reciprocity Method" (to be opened by Mr R S Dadson)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 p m —Discussion on "Air Travel from the Passenger's Point of View"

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m —Mr R G Kitchenn "An 8-Channel Transmitter for an Experimental Carrier Wire-Broadcasting System".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Prof R B Woodward (Harvard) "Some Recent Advances in the Chemistry of Natural Products"

Thursday, April 26—Sunday, April 29

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at the Central Hall The Avenue, Camberley) —Fifty-sixth Annual Congress

Friday, April 27

MINERALOGICAL SOCIETY, CLAY MINERALS GROUP (at Rothamsted Experimental Station, Harpenden, Herts), at 2 15 p m —Discussion on "Relationship of Cation-Exchange Capacity to Clay Mineral Structure" (to be opened by Prof H Deuel (Zurich) and M J Méring (Paris))

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Discussion of Papers received during the Session

CHEMICAL SOCIETY, ST ANDREWS AND DUNDEE SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Department, United College, St Andrews), at 5 15 p m —Prof F A Paneth, F R S "Whence come Meteorites ?—Views Ancient and Modern"

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, London, W 1), at 7 p m —Mr H A Macdonald "Problems of Organization"

ROYAL PHOTOGRAPHIC SOCIETY, KINEMATOGRAPH SECTION (at 16, Prince's Gate, London, S W 7), at 7 p m —Review of New Apparatus for Narrow Gauge Films

TELEVISION SOCIETY (at the C E A , 164 Shaftesbury Avenue, London, W C 2), at 7 p m —Mr J E Rhys-Jones "Time Bases"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m —Mr H M Powell "Atoms Engaged—a New Type of Compound"

Saturday, April 28

MINERALOGICAL SOCIETY, CLAY MINERALS GROUP (at Rothamsted Experimental Station, Harpenden, Herts), at 10 a m —Scientific Session, General Papers

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (at the Reynolds Hall, College of Technology, Manchester), at 3 p m —Mr H E Charlton "Chemical Engineering as applied to the Building of a Petroleum Chemicals Plant"

SYSTEMATICS ASSOCIATION (at the City Museum, Leeds) —Symposium on "Evolutionary Trends and Classification" *

Sunday, April 29

INTERNATIONAL HÆMOPHILIA SOCIETY (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W 1), at 2 30 p m —General Meeting

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN ORGANIC CHEMISTRY (to teach mainly organic chemistry up to A R I C and special degree standard), and a LECTURER IN PHYSICS (to teach physics to the standard of general B Sc degree, and applied mathematics and mechanics to Inter B Sc students)—The Principal, Gloucester Technical College, Brunswick Road, Gloucester (April 28)

SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS, SITE ENGINEERS, and TECHNICAL ASSISTANTS, by the Ministry of Fuel and Power for experiments in underground gasification (sites near Sheffield and in the West Midlands)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 306/51A (April 28)

STATISTICIAN (with experience of medical data)—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S E 5 (April 28)

ASSISTANT LECTURER IN VETERINARY SCIENCE at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (April 30)

ASSISTANTSHIP IN PATHOLOGICAL BIOCHEMISTRY at Western Infirmary—The Secretary of University Court, The University, Glasgow (April 30)

LECTURER IN BOTANY at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (April 30)

LECTURER IN CIVIL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (April 30)

PROFESSORS or LECTURERS IN GEOGRAPHY, PHILOSOPHY, MATHEMATICS, CHEMISTRY, PHYSICS, BOTANY, ZOOLOGY, ENGLISH, ECONOMICS, POLITICAL SCIENCE, at the University College of Arts and Science, Baghdad—The Director, Personnel Department, The British Council, 65 Davies Street, London W 1 (April 30)

SENIOR LECTURER OR ASSISTANT LECTURERS (2) IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (April 30)

ASSISTANT LECTURERS or LECTURERS IN AGRICULTURE, BOTANY, CIVIL ENGINEERING, and MATHEMATICS, at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (May 1)

CHAIR OF AGRICULTURE at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London W C 1 (May 1)

LECTURERS or SENIOR LECTURERS IN MECHANICAL ENGINEERING, VETERINARY ANATOMY, and PHYSIOLOGY, at the Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (May 1)

RECOGNIZED TEACHER IN BACTERIOLOGY AND ASSISTANT BACTERIOLOGIST, and a DEMONSTRATOR IN BACTERIOLOGY AND ASSISTANT BACTERIOLOGIST—The Registrar, The University, Bristol (May 1)

HYDROGRAPHIC SURVEYOR with the Geelong Trust Commissioners, Geelong, Victoria—A E Turner and John Coates and Co , Ltd , Victoria House, Melbourne Place, London, W C 2, quoting Ref 604 (May 2)

ASSISTANT LECTURER IN PHYSICS, and a LECTURER or ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W C 2 (May 5)

BIOCHEMIST (honours graduate, versed in problems of partition chromatography) to organize work in this field on vitamins, enzyme systems and amino-acids in their relation to ruminant digestion and secretion of nutrients into milk—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (May 5)

BROWNE RESEARCH FELLOW IN ZOOLOGY or BOTANY—The Provost, Queen's College, Oxford (May 5)

LECTURER or SENIOR LECTURER IN THE DEPARTMENT OF ANATOMY —The Registrar, The University, Liverpool (May 5)

LECTURER IN ELECTRICAL ENGINEERING at University College, Dundee—The Secretary, The University, St Andrews (May 7)

LECTURER IN ORGANIC CHEMISTRY at the University of Hong Kong —The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 7)

CHEMISTS (with a university degree, with first- or second-class honours in chemistry) on the scientific staff of the Chief Engineer's Department in the Research Laboratories at Leatherhead—The Secretary's Office (Establishments), Application Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W 1, quoting AE/148 (May 8)

ASSISTANT CURATOR at the Royal Botanic Gardens, Kew—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 193/51 (May 10)

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S E 18 (May 10)

RESEARCH FELLOWSHIPS (2), and a HUNTER AND PALMER'S AGRICULTURAL RESEARCH FELLOWSHIP, for independent research—The Registrar, The University, Reading (May 14)

LECTURER IN NATURAL PHILOSOPHY at University College, Dundee —The Secretary, The University, St Andrews (May 15)

SENIOR LECTURER IN GEOLOGY, with special qualifications in petrology, geophysics or economic geology, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 15)

DEMONSTRATOR IN ANATOMY—The Registrar, The University, Sheffield (May 19)

SENIOR LECTURER IN INORGANIC CHEMISTRY at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 19)

SENIOR LECTURER or LECTURER IN PHYSIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 19)

HEAD OF THE PATHOLOGY AND BACTERIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (May 31)

ELLISON FELLOWSHIPS (3) for postgraduate research in chemistry or physics—The Registrar, The University, Sheffield (June 1)

HEADMASTER—The Secretary, King Edward's School, Edgbaston Park Road, Birmingham 15 (June 16)

BACTERIOLOGIST (Grade I) to take charge, under the direction of the Professor, of the Public Health and Venereal Diseases Laboratory Service for the Bristol area—The Registrar, The University, Bristol (July 1)

LECTURER (Grade II) IN BACTERIOLOGY (Veterinary)—The Registrar, The University, Bristol (August 1)

ASSISTANT LECTURER AND DEMONSTRATOR IN THE BIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W 8

BIOLOGIST in the Department of Clinical Endocrinology (to be responsible for biological hormone assays in co-ordination with the chemist carrying out chemical assays)—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Birmingham 11

BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP, tenable in the Department of Mechanical Engineering—The Registrar, The University, Nottingham

DEPARTMENTAL RESEARCH ASSISTANT, to devote his time to the operation and maintenance of an air-driven ultracentrifuge—Dr P Johnson, Department of Colloid Science, Cambridge

DEVELOPMENT GROUP MANAGER in the Division of Atomic Energy (Production), Ministry of Supply Factory, Capenhurst, near Chester (to supervise and participate in research work at a large chemical plant)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref CC/4

EDITORIAL ASSISTANT (with a degree or chemical qualification) for *The Analyst*—Dr J H Hamence, Peek House, 20 Eastcheap, London, E C 3

LECTURER (preferably interested in vertebrate zoology), and LECTURERS (2, preferably interested in comparative physiology or entomology) IN THE DEPARTMENT OF ZOOLOGY—The Clerk, Birkbeck College, Breams Buildings, London, E C 4

LECTURER IN HORTICULTURE, and ASSISTANT LECTURERS IN GEOLOGY, MATHEMATICS (pure or applied), GEOGRAPHY (with special qualifications in regional geography and map work)—The Registrar, The University, Nottingham

MATHEMATICIANS to study theoretical problems connected with the design and performance of nuclear reactors and atomic energy plant —The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

RESEARCH ASSISTANT, for work on equilibrium diagrams of high melting alloys—Dr W Hume-Rothery, F R S , Inorganic Chemistry Laboratory, South Parks Road, Oxford

RESEARCH ASSISTANT (university graduate in chemistry with experience in biochemistry) IN THE DEPARTMENT OF CLINICAL PATHOLOGY —The Secretary, University College Hospital Medical School, University Street, London, W C 1

SURVEYORS, to take charge of Provincial Cadastral Survey offices, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27076/13

UNIVERSITY GRADUATES and QUALIFIED TEACHERS for Commissions in the Instructor Branch, Royal Navy, mainly for officers with qualifications in mathematics, science (physics, chemistry or metallurgy), or engineering—The Director (P), Education Department, Admiralty, London, S W 1

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Institute of Social Medicine Fifth Annual Report, 1949 Pp 16 A Report on the Work of the Institute of Social Medicine, 1943–50 Pp 16 (Oxford Institute of Social Medicine, 1950) [151

Review of Recent Work on Nitrogen Metabolism, by H S McKee Experimental Methods available for the Study of the Nitrogen Metabolism of Plants, a Review of some Recent Advances, by H E Street (*New Phytologist* Reprint No 21) Pp 96 (London Cambridge University Press, 1950) *7s 6d* [151

Overseas Food Corporation The Future of the Overseas Food Corporation (Cmd 8125) Pp 20 (London H M Stationery Office, 1951) *9d* net [161

Scientific Proceedings of the Royal Dublin Society Vol 25 (N S), No 12 Atmospheric Pollution in Dublin during the Years 1944 to 1950 By A G G Leonard, D Crowley and J Belton Pp 166–168 *6d* Vol 25 (N S), No 13 The Carboniferous Limestone in Co Dublin south of the River Liffey By J Selwyn Turner Pp 169–192+2 plates *6s* (Dublin Royal Dublin Society, 1950) [161

King's College Dove Marine Laboratory Report for the Year ending July 31st, 1948 Pp 30 (Newcastle-upon-Tyne King's College, 1950) *5s* [161

Department of Scientific and Industrial Research Road Research Laboratory Road Note No 5 Types of Road Surfacing and Maintenance using Tar or Asphaltic Bitumen By Dr A R Lee Second edition Pp iv+24 (London H M Stationery Office, 1950) *1s 6d* net [161

Ministry of Agriculture and Fisheries Bulletin No 97 Pests of Flowers and Shrubs By G Fox Wilson Second edition Pp iv+105+117 plates (London H M Stationery Office, 1950) *4s 6d* net [161

Colonial Office Appointments in His Majesty's Colonial Service Pp 125 (London H M Stationery Office, 1950) *2s* net [161

Other Countries

University of California Publications in Zoology Vol 50, No 1 Geographic Variation and the Species Problem in the Shore-Bird Genus *Limnodromus* By Frank A Pitelka Pp iii+108 (10 plates) (Berkeley and Los Angeles University of California Press , London Cambridge University Press, 1950) 2 dollars [151

Bulletin of the American Museum of Natural History Vol 95 Article 4 The Hawaiian Honey-creepers (Aves, Drepanidae) By Dean Amadon Pp 151–262+plates 9–15 1 75 dollars Vol 95 Article 5 Army-Ant Life and Behavior under Dry-Season Conditions 4, Further Investigation of Cyclic Processes in Behavioral and Reproductive Functions By T C Schneirla and Robert Zanes Brown Pp 263–354+plate 16 1 25 dollars Vol 95, Article 6 Species of Euxoa of Eastern North America with particular reference to Genitalic Characters (Lepidoptera, Phalaenidae) By James H McDunnough Pp 355–408 75 cents (New York American Museum of Natural History, 1950) [151

Annals of the New York Academy of Sciences Vol 51, Art 6 Methodology and Techniques for the Study of Animal Societies By J P Scott and 10 other Authors Pp 1001–1122 (New York New York Academy of Sciences, 1950) 2 50 dollars [151

Report of the Committee on the Measurement of Geologic Time 1949–1950 Pp iii+118 (Washington, D C National Research Council, 1950) 1 dollar [151

Smithsonian Miscellaneous Collections Vol 116, No 1 Comparative Studies on the Jaws of Mandibulate Arthropods By R E Snodgrass (Publication 4018) Pp ii+85 (Washington, D C Smithsonian Institution, 1950) [151

Publications of the Dominion Astrophysical Observatory Vol 8 No 6 A Redetermination of the Spectrographic Orbits of Iota Pegasi and 25 Serpentis By R M Petrie and Edgar Phibbs Pp 225–234 n p Vol 8, No 7 Spectrographic Observations of the Eclipsing Binaries DI Herculis and RY Geminorum. By Andrew McKellar Pp 235–252 25 cents Vol 8, No 8 The Absolute Magnitudes of the Early A Stars from Measures of Hydrogen-Line Absorption By R M Petrie and C D Maunsell Pp 253–280 25 cents Vol 8, No 9 Line Intensities in the Spectra of K-Type Star I Alpha Bootes and Gamma Draconis By K O Wright Pp 281–318 25 cents (Ottawa King's Printer, 1950) [151

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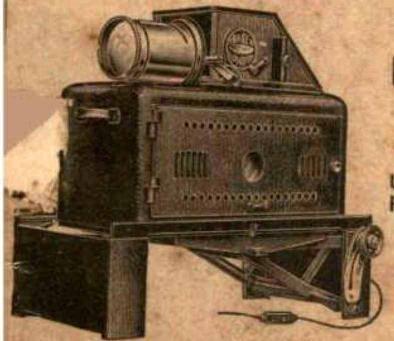
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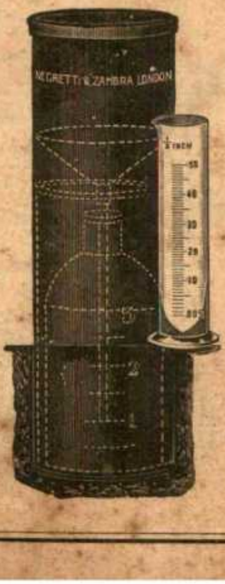
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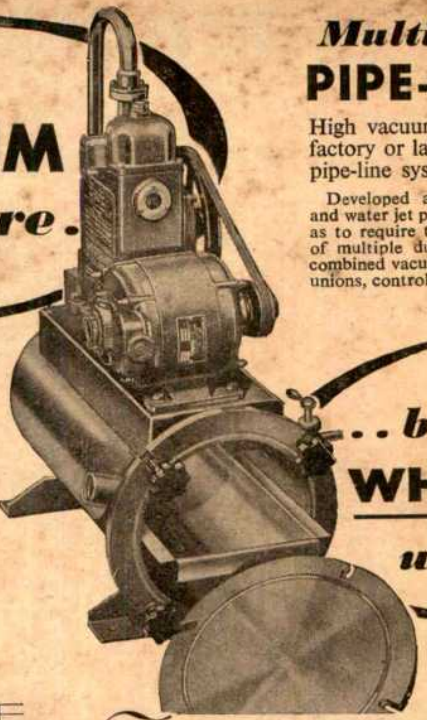

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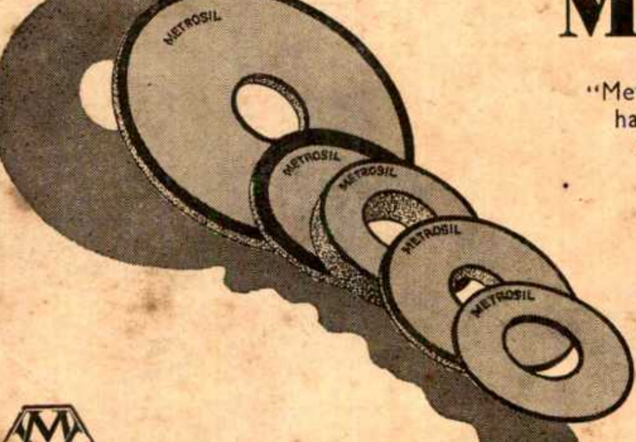

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NATURE

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Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C.2
Telephone Number Whitehall 8831
Telegrams Phusis Lesquare London
Advertisements only should be addressed to
T G Scott & Son Ltd , Talbot House, 9 Arundel Street, London, W C 2
Telephone Number Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad
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STATE SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

IN the latest annual report of the Department of Scientific and Industrial Research (see p 746 of this issue), the report of the Advisory Council differs in some respects from that in previous reports Apart from its reference to the way in which the basis of research conducted by the Department's establishments and by the research associations is being broadened by use of the methods of operational research and of comparative surveys of factory practice, so as to take increasing account of the physiological and sociological factors which go so far to determine the standard of productivity, the report has little to say on questions of policy It is concerned mainly to emphasize a few examples of the way in which the work of the Department is ministering directly to national needs, and with the financial position of some six of the research associations

Since the report of the Department for the year 1930–31, the Advisory Council's report has in the main been concerned with two or three major questions of policy, or with one or two outstanding features of the work of the Department during the year Such discussions were clearly addressed to the scientific world in general as well as to industry, and were designed to promote a considered opinion on matters vitally affecting the future not merely of the Department but also of industry and the nation in general With the growth of the Department and of the practice of the individual establishments of the Department issuing annual reports, it has clearly become impracticable, and indeed wholly undesirable, for the annual report of the Department to duplicate the individual reports, or to refer in more than general terms to many of the activities or investigations of the Department Nevertheless, in view of the expansion of the Department and the changed conditions, there should be clear ideas as to the exact purpose which the annual report of the Department, whether that of the Advisory Council or the accompanying summary of work, is designed to serve and the readers to whom it is primarily addressed

It is of some interest in this connexion to note the change in balance of the present report compared with earlier reports Twenty years ago, the last of the Advisory Council's reports over Sir William McCormick's signature reviewed the features characterizing the year's work of the research associations in general and of another ten topics The Advisory Council's report then ran to 25 pages, the "Summary of Work" to 69 pages and the account of the work of the nineteen research associations to another 25 pages When two years later the first report over Lord Rutherford's signature discussed in ten pages the flexibility of the Department, its contact with industry and the application of new inventions, the summary of work still occupied only 72 pages and the account of nineteen research associations a further 35 pages The present report of the Advisory Council runs likewise to ten pages, but shorn of the list of publications which has characterized all previous reports, the summary of work occupies 61 pages and the account of the forty research associations a further 95 pages Thus, as in last year's report, the proportion of space devoted to the work of the establishments of the Department and to that of the research associations has been almost reversed as compared with that of the pre-war decade It can reasonably be contended that the report now contains sufficient information concerning the work of the research associations to facilitate an independent judgment of the value to the nation of their work

With public expenditure on the Department reaching the £4 million level annually, and well over £1 million on the research associations alone, it is indisputable that the public should receive reasonably full information as to the return received for that expenditure Moreover, the grants made by the Department to the research associations represent only a part of this expenditure Figures given in the appendix to the present report show that the total income of the research associations in respect of the last completed year was more than £2,168 000 Support on such a scale from industry itself is unlikely to be maintained unless the industries themselves are satisfied that the effort brings a commensurate return, but even if those industries are fully informed as to the work of particular research associations, publicity regarding the work can be a decisive factor in securing the further support which some associations still require to make their work fully effective

It is fairly clear that the Advisory Council itself must be somewhat concerned as to the best way in which the necessary account of its stewardship can be rendered Much attention is indeed given within the Department to the dissemination of information about the results of the Department's investigations, and the Advisory Council's report refers to the efforts made both by publicity and by technical information services to secure the wider utilization of the results of its work All the establishments and research associations are making efforts to deal with this problem, but much remains to be done in industries for which there is no research association and to meet miscellaneous industrial needs

While, however, the annual reports of the individual establishments and boards of the Department contribute to this end, there still remains the need for some survey of the work of the Department as a whole Parliament at least must be provided with the means of assessing the value of the Department's work, and with justification for such expenditure, as the comments of the Committee of Public Accounts have indicated Only thus can there be avoided an extension of Treasury control which might be detrimental to the whole conduct of research by the Department But beyond this, the scientific world and industry in general require some such means as the annual report provides for surveying the work of the Department as a whole, and for drawing their own conclusions as to how far the expenditure of this considerable proportion of the nation's resources of scientific man-power as well as of equipment and other national resources is in keeping with national needs, and the value of the return which results from such expenditure It would, of course, be of interest to know to what extent the report is read by the general public and by what type of reader, for the present output of the Department's publications is considerable and any waste in that respect should be avoided so far as possible Nevertheless, if the assumption is correct that the report is addressed primarily to the scientific and industrial world, the omission of the list of publications from the present report appears to be false economy Inclusion of such details is a valuable aid to a reader who wishes to examine independently particular statements made or opinions expressed in the report.

On this view, however, the Advisory Council's report should, as hitherto, deal mainly with the broad questions of policy rather than attempt to stress particular achievements mentioned in the accompanying summary of work An attempt might perhaps be made to anticipate the kind of questions which scientific or technical readers are likely to ask, and to explain the reasons for important changes or trends In the present report, for example, the continuous decline since 1947 of the number of senior research awards and grants for special investigations seems to merit a word of explanation, particularly when the number of applications remains high Apart from this, the less the Advisory Council's report is concerned with detail the better It should take the broadest possible view, and set the undoubted achievements and needs of the Department in their proper perspective against the nation's resources and programme for scientific research If the Advisory Council continues to give us in its annual report, as it has often done in the past, a review of some significant features in the nation's strategy or tactics for research in which the Department of Scientific and Industrial Research must be closely concerned, that report will always be read with interest by a considerable and responsible section of the community

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PHYSICAL BACKGROUND OF CHEMISTRY

An Advanced Treatise on Physical Chemistry

By Prof J R Partington Vol 1 Fundamental Principles, the Properties of Gases Pp xlii+943 (London, New York and Toronto Longmans, Green and Co, Ltd, 1949) 80*s* net

PHYSICAL chemistry was defined by van t'Hoff as "the science devoted to the introduction of physical knowledge into chemistry", and this is the definition adopted by Prof J R Partington in setting out to write his comprehensive treatise The progress of physics and the development of modern theories of atomic and molecular structure have brought within the domain of physical chemistry much new mathematical material as well as many new experimental methods The training of physical chemists has not everywhere been fully adapted to the new conditions, and it is therefore all the more necessary to have books available which provide sufficient mathematical background for an understanding of modern advances

The volume under review is "intended to form part of a comprehensive treatise on Physical Chemistry in three or four volumes" It is thus an ambitious project, and the author deserves unstinted praise for his courage in tackling so formidable a task It does not aim at providing a mathematical treatise, devoted mainly to the theoretical aspects of the subject, but rather at giving a survey of the whole subject with emphasis on the experimental rather than the theoretical side

While the emphasis is to be on facts and on experimental methods, as is right and proper, the author recognizes the need for theory, particularly when "theory is regarded as providing equations by means of which experimental results can be calculated and interpreted" The first volume accordingly provides a long mathematical introduction (pages 1–114), and then proceeds to deal with important branches of theoretical chemistry under the headings of thermodynamics, the kinetic theory of gases, statistical mechanics and wave mechanics

The mathematical introduction begins with the subject of calculus, no previous knowledge of which is assumed, and ends with the treatment of some partial differential equations required in physical theory, such as the transmission of wave motion in matter It thus covers a great deal of ground and is necessarily condensed, but the author has obviously given much thought to the lightening of the load by omitting all that is unlikely to be useful, and he tries at every difficult stage to introduce simple illustrations of the mathematical method

The section on thermodynamics is enlivened by many practical applications of standard formulæ, as in the calculation of entropies and free energies The values of these quantities under standard conditions are displayed in extensive tables The account of the kinetic theory of gases aims at providing the formulæ required in chemical kinetics and other branches of physical chemistry It includes, for example, the theory of collisions in gaseous mixtures This is followed by a treatment of statistical mechanics in order to show how thermodynamic quantities may be calculated in terms of molecular properties The quantum theory is then introduced, and its fundamental importance in statistical mechanics is made clear This in turn leads to the subject of wave mechanics, but in the space available it is possible to deal only with simple systems An indication is given, however, of the meaning of directed atomic orbitals and their application in the theory of molecular structure

This might have been a suitable place at which to close the present volume, for there seems then to be a change of emphasis Up to this point, the treatment is mainly theoretical, with brief references only to the observed facts and the experimental methods whereby the theories have been tested, but in the two long sections which follow, on temperature and the properties of gases, it is necessary to give much more attention to the results of observation The section on the properties of gases provides a most comprehensive and up-to-date account of the subject Extending as it does to some 400 pages, with a most detailed bibliography, it might conveniently have formed a volume in itself

Immense labour must have gone into the preparation of the volume, and one cannot but admire the industry and painstaking care which has been bestowed upon it The author states in his preface that there are more than 18,000 separate references to literature in this volume and that every reference has been checked with the original whenever possible This gives some indication of the magnitude of the task Prof Partington has paid particular attention to the historical introductions to the various sections and has thus made clear the successive stages in discovery As a review of the literature this will be invaluable to the scientific historian It is interesting to note, for example, the attempts which preceded that of Van der Waals to produce a satisfactory equation of state, and to realize that the causes for the deviation from Boyle's law had already been recognized and discussed at some length, though not expressed in quantitative form At the same time, it may be well to realize that an unduly extensive list of references may have a repressive as well as a stimulating effect on the reader, unless the 'high spots' in the vast panorama are clearly brought out, so much time may be spent in following up previous work as to leave little opportunity or incentive to do creative work

It would, of course, be easy to find points to criticize in a book covering so wide a field, for no two opinions agree on the relative emphasis to be given to its various parts But all will agree that Prof Partington has produced a scholarly and monumental work, and in doing so has created a lasting impression of scientific sincerity and great erudition No library of chemistry, or of physics, should be without a copy, and no earnest student of physical chemistry will ever regret the modest outlay which its purchase involves

J E Lennard-Jones

CYTOCHEMISTRY OF PROTEINS AND NUCLEIC ACIDS

Cell Growth and Cell Function

A Cytochemical Study By Prof Torbjoern O Caspersson (Thomas William Salmon Memorial Lectures) Pp 185 (New York W W Norton and Co , Inc , 1950) 5 dollars

ONE of the most fascinating developments in cell biology during the past fifteen years has been Prof T O Caspersson's study of cells by the techniques of ultra-violet microscopy The taking of photographs of cells by means of ultra-violet light, of course, considerably antedates Prof Caspersson's work The new contribution which he has made lies in two things the first is the development of quantitative methods for determining the absorption of light by cells, and the second has been his interpretation of the results so obtained, and the resulting impetus which has been given to studies of the biological significance of pentose nucleic acid

This little book is a very valuable review of the work which has been carried out in this field in Prof Caspersson's laboratory It begins with a discussion of the physical principles which underlie the studies This includes discussions of the properties required in optical systems, and carries on to discuss what the nature of the examined specimen must be if it is to be successfully examined, and the methods which may be used for deducing the types of substances in cells which are responsible for the absorption of light at various wave-lengths.

In subsequent parts of the book the results obtained by Prof. Caspersson's methods are reviewed in some detail. The main headings include the formation of proteins during the process of mitosis, the formation of proteins in inter-mitotic cells, including the secretions of various glands, the formation of hæmoglobin, and the formation of protein in nerve cells. Subsequent chapters deal with the peculiarities of a number of types of tumour, and of what Prof. Caspersson calls the "simpler systems". The "simpler systems" particularly include the formation of proteins and nucleic acids by yeast, bacteria and viruses.

In the methods which Prof. Caspersson has employed, there is, to some extent, an unevenness of the excellence of treatment. With regard to the discussion on optical apparatus, the work appears to be above reproach, as far as the reviewer can judge. But the treatment of the specimens and the interpretation of the results are more open to question. There can be no doubt that much more consideration must be given to the actual condition of the specimen which is being investigated. A great deal of the work has been carried out with material fixed with chemical fixatives. It is now known that during fixation with chemical substances, diffusion of nucleic acid or nucleoprotein occurs to a very serious extent. Fixation by the freeze-drying technique must be considered obligatory.

Then, too, the actual interpretation of apparent extinction coefficients must be subjected to further analysis. This is required in at least two ways: the errors due to scattering of light in the specimen, and errors due, for example, to failure to follow Beer's law, require further attention; and considerable doubt must be felt about the interpretation of extinction coefficients at individual wave-lengths. With regard to the latter point, at present the procedure is to take the half-dozen substances which are most likely to occur in a particular cell, and assume that practically the whole of the absorption of light is due to these substances. This takes too limited a view of the diverse chemical activities of living cells. To take one simple example, the absorption of light at 2650 A. is probably, in most cells, mainly caused by purines and pyrimidines. In most work on cells it seems to be assumed, without question, that this is so, and it is further assumed without question that the purines and pyrimidines concerned must be present as part of nucleic acid molecules. This is an accumulation of assumptions which sooner or later is bound to lead to trouble. For example, a protein which had as part of its constitution purines or pyrimidines would have an ultra-violet absorption at 2650 A. which would be practically indistinguishable from that of nucleic acids.

However, while there are undoubtedly many points in quantitative microspectrophotometry which need very much more careful examination than has been provided at present, the most important thing about this book is the fact that, by vigorous exploitation of new physical techniques, an immensely valuable impetus has been given to the field of cytochemistry. To the student of cells, and indeed of all animals and plants the tissues of which cannot be obtained in large quantities, the theories of biochemistry must remain unsubstantiated to a depressingly high degree until the development of cytochemical techniques is sufficient to enable comparative and cellular biochemistry to become a reality. Until this happens, comparative studies are inevitably limited to the small number of tissues which can be obtained in amounts large enough for study by the classical methods of biochemistry. To all who are interested in the development of cellular techniques, Prof. Caspersson's book will be an invaluable guide.

PHYSICAL REALITY

The Nature of Physical Reality

A Philosophy of Modern Physics. By Prof. Henry Margenau. Pp. xiii+479. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 55*s.* 6*d.*

PROF. HENRY MARGENAU'S book is the fruit of clear and profound thought based upon massive knowledge. His discussion is arranged with great care and presented with a mastery of vivid prose. He believes that the book can be used as a text on "the methodology of the exact natural sciences" by senior undergraduates in physics or in philosophy who have had some introduction to the one of these subjects in which they are not specializing. I am convinced that it will prove admirable for this purpose, at any rate with the aid of some expert guidance. But the book deserves also the serious attention of professional physicists and philosophers.

It is a systematic analytical description of what physical science does; it can perhaps be termed a modern 'grammar of science'. After some preliminary discussion of the common notions of experience and reality, the author states what is meant by science and, in particular, by a "theoretical science". Then follows an analysis of the status of what is immediately given in experience, and of the passage from this to 'constructs' such as a tree or an electron. The author sets forth the 'metaphysical' requirements that are deemed to render particular constructs acceptable to science. He then analyses the procedures by which theories conforming to these requirements "attain validity" by empirical confirmation. Much of what follows are expositions of the foundations of theories of space and time, mechanics, electromagnetic fields, thermodynamics, probability, statistical mechanics and quantum mechanics. These are valuable and illuminating, even apart from their bearing upon the more general matters under consideration.

These matters are treated at suitable stages and include explanations of "systems", "observables" and "states" in physics, the place of "definitions" in science, measurement, causality, prediction, the philosophy of Pauli's exclusion principle and comments upon the possibility of extending the notions involved to other fields of thought. Here there is space to consider briefly only the matter which the author regards as the most important, the nature of physical reality.

For him, "valid constructs" are the elements of physical reality. In effect, he maintains that these are the entities that come nearest to satisfying our prior notions of reality, that physical existence *is* reality in his sense. Therefore he seems to be doing something more than merely defining his use of the term 'real'.

I think that something like Prof. Margenau's conclusion with regard to reality in physics is almost inevitable when physics is treated as a "theoretical" science in his sense But there is still the problem shown by the fact that, while his physics is very much interested in the existence of, say, planets or pieces of iron or neutrons, it seems to be quite indifferent to what *particular* planets or pieces of iron or neutrons do exist in the ordinary sense. In other words, his definition seems to have little to say about the existence of what we usually call the real world—that is, when this is regarded as a unique system

If I understand Prof Margenau's view rightly, he would regard such reality as coming partly into 'historical' reality, which he recognizes as complementary to, but merging with, his physical reality, and partly into the philosophy of existence, which he distinguishes from the philosophy of science On the other hand, the reality in question is now becoming the concern of physics in its application to cosmology This does concern itself with the unique real universe There is, of course, no guarantee that current physics is competent to deal with those aspects of the problem for which the uniqueness is relevant But, if it is, we should expect to gain further insight into the meaning of physical reality

W H McCrea

STELLAR ENERGY AND EVOLUTION

Astronomy of Stellar Energy and Decay

A General Reader's Outline of Facts and Theories about the Life-history of Stars, and a Student's Introduction to their Radiation, Steady or Varying or Catastrophic By Dr Martin Johnson Pp 216+4 plates (London. Faber and Faber, Ltd, 1950) 16s net

THIS volume is described as an attempt to bridge the gap between popular astronomy and the research literature of stellar physics, in particular that part which deals with stellar constitution and evolution According to the preface, its origins are to be found in lectures to general audiences under a university's extra-mural board and to "many years of attempting, with frequent success, to infect senior students of physics with the desire to see their laboratory knowledge exemplified in the large-scale processes of Nature" Although sympathetic to both these activities, especially the latter, I have misgivings about trying to cater in one book for such a wide range of readers Judging by the contents, some of these are supposed not to be familiar with the most elementary nomenclature of the constellations, or the distinction between weight and mass, while others are judged capable of digesting at short notice the key formulæ of the theory of stellar interiors

The subject is one of great difficulty, not because of the complexity of present ideas, but because we have so little chance of checking theory by observation. We cannot examine the interior of a star by practical methods, and the slow pace of evolution makes it for the most part equally inaccessible in time We see a wide variety of stars in the sky, but our sampling is gravely distorted by observational selection and may still be far from complete We are uncertain whether the varieties seen represent typical stages in the life-history of one star, or whether they are samples of independent species From the point of view of evolution, what is the significance of the unstable novæ, the regularly varying Cepheids, the extremely dense white dwarfs, the open clusters, the globular clusters, or Populations I and II? No final answer can be given at present to these or many other questions Twenty years ago Eddington believed that a star is in its essentials a simple structure, we are less confident to-day, and already our theories are appreciably more complicated than they were then

Dr M Johnson, in this sketch of the subject, has aimed at keeping clear the frontier (not always sufficiently sharply defined in astronomical literature) between firmly based observational facts or generally accepted theories on one hand, and, on the other, that vast and fascinating hinterland of more or less speculative uncertainty which is to be found near the limits of our astronomical knowledge In this he has had a measure of success, even though the specialist reader may wish to move the boundary a little this way or that in particular cases Dr Johnson is to be commended, too, on seeking to explain the importance of 'models' in the theoretical study of stellar structure, and might, indeed, have profitably spent more space on this subject Despite some refreshing virtues, however, the book is not above criticism In at least two places the reader is left with the entirely erroneous impression that giant and dwarf stars of the same surface temperature differ only in density and not in mass The description of practical techniques is so brief and vague that readers otherwise uninstructed will not find much enlightenment Occasional sentences are clumsily constructed, and the author is inclined to obscure his meaning by a somewhat tortuous style of writing

However, the acid test is whether the book can stir the curiosity and whet the appetite of beginners If it can, it will have justified itself. The short bibliography at the end of his work suggests that this is the author's chief aim, and in this task he will have the good wishes of all astronomers

R O Redman

DIVERGENT SERIES

Divergent Series

By Prof G H Hardy Pp xvi+396 (Oxford Clarendon Press, London Oxford University Press, 1949) 30s net

WHILE it is true, as Prof J E Littlewood has remarked in the preface to this book, that the subject of divergent series has lost the sensational and paradoxical flavour which it had when he and Prof G H Hardy began their work on Tauberian theorems, it still remains one of the most important branches of modern analysis and certainly one of the most attractive

The peculiar formal elegance of the subject and the interest of the delicate techniques which it requires are brought out to the full in this book, and it is hard to imagine a more pleasant or readable presentation of a subject of comparable difficulty While it is plainly impossible to cover the whole field of divergent series exhaustively in a single work, the book contains enough to give a non-specialist reader a balanced picture of the main development of the theory into its modern form and, at the same time, to provide the specialist with an invaluable reference book from which it is only a short step to matters of contemporary research interest

A short historical survey of the many ideas which have been held about divergent series is followed by an account of the general theory of regular transformations of series, including the Toeplitz – Schurr theorem on necessary and sufficient conditions for regularity, Knopp's theorem on positive transformations, and a discussion of the extension of the theory to integral transformations of functions of a real variable

The main part of the book is then devoted to a full account of most of the standard methods of summation and the Abelian and Tauberian theorems associated with them It includes proofs of the classical Tauberian theorems of Hardy and Littlewood for Cesàro and Abel summation, with a sketch or the original proof of the latter by the repeated differentiation technique, as well as the later and simpler proof of Karamata The basic ideas in these earlier works are discussed in more detail in their application to the Hardy – Littlewood theorem for Borel summation with the $O(n^{-\frac{1}{2}})$ type of Tauberian condition

The book also contains a large amount of material on the less-familiar summation methods In particular, there is a very attractive introduction to the theory of Hausdorff methods, including Euler's, and an account of the elegant formal relationship between the latter and Borel summation

The part of the book given to Wiener's methods is short, but it is enough to provide an account of the general Tauberian theorem in a form which makes its application to all the standard methods seem natural and straightforward The power and generality of the method is illustrated by its use in the 'one-sided' form of the Borel – Tauberian theorem

Among the many other topics discussed are the Euler – Maclaurin summation formula, the multiplication of series and the Fourier kernels of summation matrices, and there are many illuminating comments and suggestions in the notes at the end of each chapter H R Pitt

BIRDS OF GREENLAND

Grønlands Fugle (The Birds of Greenland)

Part 1 Text by Finn Salomonsen, plates by Gitz-Johansen Pp 158+17 plates (København Ejnar Munksgaard, 1950) 60 Danish kr, 66s

Mr GITZ-JOHANSEN, a well-known Danish artist who has specialized in Greenland subjects while travelling in that country, made a number of pictures of the birds He decided to publish these paintings and asked Dr Finn Salomonsen to write an appropriate text They are not the usual kind of illustrations one is accustomed to in a faunal work, and doubtless will not please the critical eyes of some ornithologists It must, however, be remembered that Mr Gitz-Johansen does not pretend to be a bird artist but has painted the birds as they appear to him The birds of Greenland have always been of special interest to ornithologists in the British Isles, since many pass through these islands on migration, while others spend the winter here

The earliest account of Greenland birds appeared in a book by H Egede in 1741 The author founded a missionary colony at Godthab, where he lived during 1721–36, and refers in his book to twenty-five well-known species Most of the work on the avifauna of Greenland has been done by Danes, but ornithologists in Great Britain, too, have made many notable contributions

The explorers in search of the North-west Passage made collections of birds while their ships were being worked up the Davis Straits between the ice and the coast of Greenland It was on such an occasion that Sir Edward Sabine, who accompanied Parry on his first voyage in 1819, obtained specimens of the small gull that now bears his name, and two years later Mr Ross, afterwards Sir James Clark Ross, shot two examples on the Melville Peninsula of the rare rosy-coloured gull, which Richardson named after him At a much later date, Prof Newton prepared for Sir George Nares's expedition in 1875 in the *Alert* a useful summary of Greenland birds that were known up to 1875 By far the most important publication, however, is H Winge's "Grønland Fugle", published in 1898, and for long the standard work although now out of date Dr Salomonsen's new account is therefore very welcome, more especially since it is in Danish and English in parallel columns, and we shall look forward to the completion of the work

The author has paid several visits to Greenland to study birds in the field, and in Denmark he has had the large collections in Copenhagen at his disposal Part 1 includes the divers, petrels, ducks and their allies, and the cormorant Of the two divers, the red-throated is very common, and Dr Salomonsen in one night saw a hundred in the air at one time making for the sea to feed The major portion of this part deals with the geese and ducks, about which Dr Salomonsen has much to tell According to the ringing-returns, the Greenland race of the white-fronted goose is confined in winter to the British Isles The Greenlanders apparently do not shoot many of the old birds, but they catch many goslings and sell them in the settlements for fattening for Christmas No doubt foxes and eagles also take a considerable toll Among the ducks the Greenland race of the common mallard is of special interest It differs in colour from European examples, but more important is the fact that it is resident in these northern climes

In the autumn the birds leave their inland nesting-haunts for the sea, selecting places where the currents are strong and the ice seldom forms There they collect together in flocks and feed in the littoral zone on crustaceans and molluscs Should the weather become very severe and ice is formed, areas of seaweed are exposed as the tides fall, and there the birds can find a feeding ground The form of the eider-duck found in Greenland is smaller than the bird in Great Britain and the Continent It is the most important duck in the economy of the Greenlanders, who formerly shot birds for food at all times of the year, collected vast numbers of eggs for winter use, and made coats and bed-covers of plucked skins These last were exported to Denmark, as many as 1,300 in a year, and as it takes a hundred skins to make one bed-cover, the drain on the numbers of eider-ducks was enormous Fortunately the Government in 1938 issued orders restricting the slaughter of birds and collection of eggs, and in addition the exportation of skins was prohibited All this has had a very beneficial effect

The king-eider, a brighter-coloured bird than the ordinary species, has in the male a bright-coloured knot on the front of the head It is not uncommon in the northern areas Dr Salomonsen mentions a curious habit of the Greenlanders who, when shooting one of these ducks, at once bite off the knob and eat it raw—considering it quite a tit-bit

N B Kinnear

Précis de microscopie

Technique, expérimentation, diagnostic Par M Langeron Septième édition entièrement refondue Pp viii+1430 (Paris Masson et Cie , 1949) 2600 francs

THE new edition of this well-known text-book fulfils expectation The book has two main attributes that together make it preferable to most of its competitors it has the coherence that results from its being written by a single author , and there is more scientific explanation in it, and less purely empirical matter, than in most other books on micro-technique The chemistry underlying staining re-actions, etc , is explained in a simple, direct manner , some of these explanations are particularly well done (for example, the account of the use of methylene blue and related dyes in staining blood-smears)

There is abundant evidence that the author has both theoretical knowledge and practical experience in very diverse parts of his subject Much good common-sense is to be found in what he writes about microscopy itself, particularly in his strong recommendation of the opal bulb as an illuminant, and his insistence on the good results obtainable with condensers that are not highly corrected, in routine work , but he does not sufficiently stress the importance of the field-stop, nor does he adequately explain the focusing of the bull's eye, when this is used with an intense light-source Also, he uses a very much narrower illuminating-cone than most experienced microscopists The section on photomicrography is weak the treatment is not general enough, too much space being devoted to a particular apparatus There are a few errors, as is perhaps inevitable in such a large work as this Thus, the author says that in phase-contrast microscopy the objective is used at full aperture, which would only be true if the phase-plate annulus were situated at the periphery of the aperture of the objective He also makes the astonishing statement that dark-ground illumination is invariably produced by total reflexion at the surface of the coverslip These, however, are minor matters

The book can be confidently recommended to British microscopists and micro-technicians

JOHN R BAKER

Electrical Measurements and the Calculation of the Errors Involved

By D Karo Part 1 Pp 191 (London Macdonald and Co (Publishers), Ltd , 1950) 18*s* net

MOST text-books on practical physics include a chapter dealing with the calculation of errors nvolved in experimental work, and one wishes that students would digest this at the earliest opportunty Very often this wish is unfulfilled, and students, especially in the early stages, proceed with the experiments without a full appreciation of the degree of accuracy to be expected at the end

In this book Mr D Karo compels the student to onsider errors, both systematic and accidental, for he demonstrates the relative usefulness of different methods of measurement by calculating the errors involved in each and the limitations of various nstruments, and also indicates the conditions in which each should be used It is true the work overs the whole syllabus of the final degree examnation in electrical measurements, but the book can be used with profit even by students preparing for he intermediate examination, for this latter is the ime when they should begin to appreciate the value of their experimental observations , the first two chapters should certainly give such students invaluable information

The book starts admirably "A measurement of any kind is of use only when the limits of the maximum possible error are known" If only students would realize this early it would save a lot of time and trouble Altogether, this is an extremely useful book, particularly for finals students, research workers and engineers

Relations entre les phénomènes solaires et géophysiques

(Questions d'actualité éditées par les *Annales d'Astro-physique* et les *Annales de Géophysique*, 1 Colloque International tenu à Lyon en 1947) Pp 312 (Paris Éditions de la *Revue d'optique théorique et instrumentale*, 1949) 1800 francs

THIS record of papers, presented to the Conference on Solar-Terrestrial Relationships which was held at Lyons in 1947, shows to even the casual reader what a wide range of phenomena are affected, or even controlled, by solar radiation, electromagnetic or corpuscular Study of the sun is now of importance to physicists, radio engineers, geomagneticians and meteorologists, as well as to astronomers That the author index to the volume reads like an international scientific directory confirms the world-wide appeal of the subject

It is perhaps scarcely fair to expect more than the thinnest unifying thread running through the whole work it is no more than a series of research papers of uneven quality on related topics, each accompanied by a record of the discussion it aroused at the Conference Regarded as an interim report on work in progress on a very live subject, however, this should be on the shelves of every geophysicist and astronomer It is a pity that the quality of the paper is barely adequate even for the letterpress , the attempt to reproduce photographs in half-tone on this same low-grade paper fails miserably

Organic Chemistry

A Textbook for Science and Medical Students By Dr Frederick Prescott and Dr Dudley Ridge Second edition Pp iv+724 (London · University Tutorial Press, Ltd , 1950) 14*s* 6*d*

THE scope of this book is intended to cover the organic chemistry required for the general-degree examination and that needed by second-year medical students The chapters dealing with carbohydrates, purines, proteins and fermentation are fuller than usual, in order to meet the needs of medical students In the second edition a new chapter on isomerism and polymerism has been added, in view of the increasing importance of plastics The book follows the usual plan, and special emphasis is given to details of preparation, these sections being sufficiently detailed for laboratory use

The methods of preparation and properties of groups of substances and individual compounds are clearly and comprehensively set out, and the text is well suited to students beginning the subject, who should find the book intelligible and interesting Examination questions at the ends of the chapters will be useful to students and teachers Although the classical theories, including stereochemistry, are adequately treated, electronic theories are excluded as beyond the scope of the book This is a clear and good treatment of elementary organic chemistry

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1949–50

THE annual report of the Department of Scientific and Industrial Research for the year 1949–50* includes, as usual, the report of the Committee of the Privy Council, over the signature of the Lord President of the Council, and that of the Advisory Council over the signature of Sir Ian Heilbron, together with appendixes listing the assessors to the Advisory Council and members of the research boards and committees of the Department, the research associations, and summaries of the expenditure of the Department for the year, including maintenance allowances to students and research awards and grants. One appendix is missing this year, namely, the customary list of publications issued during the year, which last year occupied some forty pages of the report. The greater part of this year's report consists of the summary of work, and of this some hundred pages deal with the work of the research associations as against sixty dealing with the activities of the Department's various research stations and boards; the latter, however, have for the most part already been described in the several annual reports already issued by individual stations or boards.

The gross expenditure of the Department for the year ended March 31, 1950, was £4,346,580, as against £3,696,945 in the previous year, but this was reduced by receipts from various sources to £3,913,782, the net increase on 1948–49 being £640,673. The total staff of all grades employed in the Department on October 1, 1950, was 3,916 (including 135 part-time), an increase of 455 on 1948–49 and of 758 on 1947–48. Of the net expenditure, the largest single item was the annual grants to research associations totalling £1,099,714, besides special grants amounting to £26,678. Gross expenditure on the National Physical Laboratory was £721,251, but receipts reduced this to £467,250. Grants for special researches amounted to £344,410, an increase of £75,731, and grants to students to £212,055 net. Net expenditure on building research was £255,333, on road research £226,057, on fuel research £188,965, on food investigation £185,406, on forest products research £85,573, on mechanical engineering £82,666, on radio research £65,685, on water pollution £41,906, on pest infestation £39,043, and on hydraulics £18,175. Apart from the increase of £64,894 in expenditure on mechanical engineering, the order of expenditure is in general that of the previous year, though expenditure on both fuel research and food investigation increased by about £40,000. Of the gross expenditure of £114,050 on the Chemical Research Laboratory, £35,758 was covered by receipts, and receipts amounting to £21,261 again covered more than half the gross expenditure of £40,884 on fire research. Net expenditure on the Geological Survey and Museum was £149,309, on headquarters administration £91,064, on headquarters intelligence £47,092, and on headquarters overseas liaison £41,792. The corresponding figures for the last three items in 1948–49 are £79,237, £32,109 and £31,483, respectively, and in view of what is said in the Advisory Council's report about strengthening the contacts between headquarters and the stations and research associations, and the increased responsibilities of the Intelligence Division of the Overseas Liaison, these increases seem moderate. Research contracts amounted to £139,134 as against £45,459 in 1948–49.

Although the grants to students, etc., increased by £51,457 over the figure for 1948–49, and the number of students in training increased from 736 to 828, senior research awards decreased from 23 to 16, and grants for special investigations from 99 to 93. Of the last two items, five and twelve, respectively, were new awards, and the preponderance in chemistry and physics continued; ten senior research awards were in chemistry and fifteen in physics, while of the grants for special investigations, twenty-four were in chemistry, forty-three in physics, eleven in engineering, six in biology, five in mathematics and astronomy and four in geology and mineralogy. Of the grants to students, 308 were in chemistry, 285 in physics, 62 in biology, 63 in engineering, 46 in mathematics and astronomy, 36 in metallurgy, and 28 in geology and mineralogy; of these grants, 376 were new.

Much of the information regarding the work of the research boards and stations of the Department is available in the annual reports of individual boards or stations which have already been published. The report of the Advisory Council, however, selects some examples to illustrate the way in which both the establishments of the Department and the research associations are meeting national needs. With the transfer from the Chief Scientific Adviser's Division of the Ministry of Works of work on user requirements and the economics of building, the conduct of all building research is now the responsibility of the Department. Besides its work on the design of steel-frame buildings when welded rigid joints are used, and on the bearing capacity of soils in relation to foundations of large structures, the Building Research Station has been concerned with many factors affecting the efficiency of buildings, such as the choice of colour schemes in factories so as to reduce visual strain and thus aid production.

Of particular importance at the present moment is the work directed towards improving the supply of sulphur. The work of the Chemical Research Laboratory on sulphate-reducing bacteria, originally concerned with the prevention of corrosion of iron pipes in waterlogged soils and with the disposal of refuse, now offers a possibility of relieving the sulphur situation by microbiological production. The chief obstacle to the industrial exploitation of a process of producing sulphur by this means from lakes in Cyrenaica is the low specific rate of reduction of sulphates, and research is proceeding with the view of accelerating the process. Work under the Gas Research Board has shown that sulphur of 99 per cent purity and otherwise satisfactory for the manufacture of sulphuric acid by the contact process can be obtained from the spent oxides of gas works, while plans are well advanced for semi-scale trials at a steelworks in South Wales of a new process, worked out by the British Iron and Steel Research Association, for regenerating sulphuric acid from spent pickling liquor.

The Road Research Laboratory, besides its investigations on dazzle and on road safety, which, for example, led to an 85 per cent reduction in the number of accidents in wet weather over a stretch of Finchley Road, Hampstead, through re-surfacing with hot-rolled asphalt in place of wooden blocks, has made important contributions to reduction of cost of maintenance of surface-dressed roads The increased and more efficient use of mechanical devices for spreading tar and chippings has within the past three years reduced the labour cost in one county from 2*d* to ½*d* per square yard Large-scale studies by the Joint Fire Research Organization of the development of fire have yielded results of immediate importance in deciding the protection to be given to houses, and other work is being carried out on the conditions which determine the initiation and growth of fire, as well as on the use of water in extinction of fires, forest fires and dust explosions in factories

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* Department of Scientific and Industrial Research. Report for the Year 1949–50. (Cmd. 8169.) Pp. 214. (London: H.M. Stationery Office, 1951.) 4s. 6d. net.

Work on the handling and stowing of chilled (iced) fish has reached a stage affording a basis for 'icing codes' for ships of various construction and equipment, while, with the co-operation of the Agricultural Research Council, feeding trials are in progress of high-quality protein feeding-stuffs obtained by alkali digestion of surplus herrings Systematic studies are being made of the effect of temperature and duration of storage on the deterioration of fresh vegetables, and, in co-operation with the Ministry of Agriculture and the Ministry of Food, surveys are being made of the conditions to which vegetables are exposed during distribution and marketing The Low Temperature Research Station is developing a method for the direct plating of aluminium with nickel, which may meet the need of the food and other industries for a cheap and light-weight metal of bright appearance which does not corrode and can be soldered

The full-scale investigations on the properties of Colonial timbers continue to be a major preoccupation of the Forest Products Research Laboratory, but some long-term research on the physiology of starch depletion and of heartwood formation has been begun, as well as an investigation into the causes of the distortion of plywood A yield-measurement scheme for assessing quantitatively the suitability of any species for plywood manufacture is undergoing its final trials, and alternatives to creosote are being tested as preservatives for external timber in view of the possibility that supplies of creosote may be inadequate The Fuel Research Station is engaged on the development of coal-fired gas-turbine plant, particularly with regard to the design of combustion chambers, methods of dust removal and the problems of blade fouling A vortex combustion chamber has been designed to burn 500 lb of coal per hour at atmospheric pressure with a heat release of about 500,000 B Th U per cu ft per hour, while another type of chamber, based on that used for firing Lancashire boilers with pulverized coal, gives a higher combustion efficiency but only about one-third of the heat release of the vortex unit Smoke elimination from industrial boilers, the removal of sulphur from flue gases and the recovery of sulphur from indigenous sources have been investigated by the Station, which is also responsible for co-ordinating, analysing and publishing results of atmospheric pollution observations made in Great Britain

The new Hydraulics Research Station is expected to be ready for occupation in the present year, and meantime work has continued at the National Physical Laboratory, the universities and the Royal Victoria Dock of the Port of London Authority on the Wyre tidal model, the Forth model, the River Eden model and the Fassideri Spillway model The Forth model has already indicated that the construction of piers and dredging around the Beamer Rock would have a negligible effect, that removing the Beamer Rock would increase stability of flow and increase silting, and that constructing embankments to enclose lagoons into which dredged materials would be dumped, by reducing curvature, would slightly decrease tidal flow Some of the buildings of the new Mechanical Engineering Research Laboratory at East Kilbride are expected to be ready for occupation in 1951, and the committees set up by the Board are paying special attention to the equipment of the Laboratory Some research on the fundamental mechanisms of fatigue failure has been started at the University of Bristol, work on photoelasticity has been expanded and some basic work on the properties of materials on the macro-scale in the plastic region has been started in the National Physical Laboratory In the Division housed at Thorntonhall, work is directed to the elucidation of the fundamental causes of friction and wear, and to the solution of generic problems arising from the practice of lubrication

In the Pest Infestation Laboratory, a considerable measure of success has been attained in the control of blowflies in slaughterhouses with DDT dust, while the discovery that all stages of the development of the common clothes-moth are killed by a few hours exposure to a temperature of 41° C at a relative humidity of 70 per cent is being pursued with the view of its utilization as a practical method of control The Radio Research Organization continues to be engaged on an extensive programme of fundamental research, and a sub-station at Fraserburgh has been maintained during the year in addition to the work at the National Physical Laboratory and at the Radio Research Station at Slough At the Road Research Station a study of the construction of roads over peat has started Collaboration of the Water Pollution Research Laboratory with the countries of the Commonwealth is increasing Experiments have been started in collaboration with the Gas Research Board's Advisory Panel on Ammonia Effluents to determine the effect on biological treatment of sewage of constituents of spent liquor from the manufacture of coal gas Assistance has also been given in the development of processes for the treatment of water for Tehran in Persia

Some illustrations have already been given of the work of the research associations Attention is directed by the Advisory Council's report to the increasing use of the process devised by the Wool Industries Research Association for rendering wool unshrinkable, production now exceeds 2–3 million lb a year, and an indirect effect has been the development by the hosiery industry of processes for rendering its products unfeltable The same Association has continued its work on detergency and the action of detergents in scouring as well as on the products formed by the action of papain and sodium bisulphite on wool The precision grade system of fitting shoes developed by the British Boot, Shoe and Allied Trades Research Association is being more widely adopted and is leading to developments in the standardization of size-markings Steel-works are obtaining increases up to 20 per cent in output as a result of installing a new and simpler air inlet to steel furnaces, which has been developed by the British Iron and Steel Research Association in co-operation with the industry, while the 3,500 h.p. gas turbine, designed to drive a propeller directly, which the Parsons and Marine Engineering Turbine Research and Development Association is developing, offers great potential advantages over the steam turbine in efficiency, weight and adaptability.

The work of the British Baking Industries Research Association on the staling of bread has made it possible to relate the chemical composition of anti-staling agents to retardation of staling, and to suggest optimum levels for inclusion in the formula used with particular commercial products. A combination of fat and glyceryl stearate products appears to offer the further advantage of increasing the nutritional value. The Research Association of British Flour Millers has studied the milling behaviour of biscuit and confectionery flours in relation to the structure of the wheat grain, and has elucidated the chemistry of the toxic factor formed by the action of the flour improver, agene (nitrogen trichloride), on proteins, as well as completing a three-year survey of the milling and baking value of winter-sown home-grown wheat. Investigations designed to increase production include those of the Hosiery and Allied Trades Research Association on the use of suitable backgrounds, lighting conditions and magnifying aids to reduce eye-strain, and of the British Hat and Allied Feltmakers' Research Association on acid control in felt manufacture. The British Launderers' Research Association has investigated the chopped fibre technique for the evaluation of detergents and obtained good agreement with full-scale results. The British Non-Ferrous Metals Research Association has now obtained some light on the causes of localized corrosion or pitting of copper water pipes. The fundamental work on the reactions occurring in the polymerization and oxidation of drying oils is being pursued by the Paint, Colour and Varnish Manufacturers' Research Association, and the British Paper and Board Industry Research Association is considering the utilization of waste linseed straw from United Kingdom flax. The Research Association of British Rubber Manufacturers is investigating the possibility of using common materials occurring in the United Kingdom, such as calcium carbonate, as alternatives to carbon black for 'reinforcing' rubber.

LABELLING OF PROTEINS WITH IODINE-131, SULPHUR-35 AND PHOSPHORUS-32

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THE use of isotopes, particularly those which are radioactive, for the labelling of proteins and related compounds is now being widely adopted for many investigations in biochemistry and medicine. Early in 1939, we prepared mustard gas (di-2-chloroethyl sulphide) containing sulphur-35 for investigations on the action of mustard gas and its derivatives on animal tissues, and on the immunological properties of proteins treated with mustard gas. (An account of these war investigations was published in 1946[1].) Afterwards, we used proteins labelled with sulphur-35 and phosphorus-32 for quantitative studies on the precipitin reaction[2], and in other immunological studies[3] we have used proteins labelled with iodine-131.

The isotopic labelling of proteins can be effected by normal laboratory chemical methods, but the treatment involved frequently effects several changes in the protein molecule in addition to the attachment of a label or labelled group. Treatment of serum proteins with phosphoryl chloride, for example, results in the phosphorylation of the hydroxyl groups of several amino-acid residues, but it almost inevitably causes denaturation and other changes in the protein. When proteins are treated with mustard gas sulphone (di-2-chloroethyl sulphone) the reagent reacts very readily, at room temperature and *p*H 7·5, with the free amino groups of the protein, but the possibility of other changes in the protein molecule cannot be excluded. Iodination of proteins leads to the introduction of iodine into the 3 : 5-positions of the tyrosine residues, but other groups (for example, histidine) may be iodinated, sulphydryl groups are oxidized and other changes may occur[4]. Thus the use of large amounts of labelling agents such as iodine, mustard gas sulphone and phosphoryl chloride for the introduction of several 'tags' into each protein molecule may result in the production of a chemically altered protein with properties significantly different from those of the original protein. Obviously, this is a serious drawback for many biological investigations.

Now that certain radioisotopes are becoming more generally available in the form of preparations of high specific activity, it has been possible to 'trace-label' proteins with some of these radioisotopes. In this way one can reduce very considerably undesirable changes such as denaturation, hydrolysis and oxidation. For example, it is possible to iodinate proteins using an extremely small amount of radioiodine, and to introduce an average of one or two iodine atoms per molecule of protein, with little or no detectable change in the chemical and physical properties of the protein.

Some proteins can be biologically labelled, as, for example, casein[5], lipovitellin[6], and nucleoproteins, all of which have been labelled biologically with phosphorus-32. Several other proteins can be labelled biologically with radioactive isotopes[7]. This biological method yields proteins which are, for practical purposes, completely 'physiological', apart from the label; it is, however, of rather limited application, and unless large amounts of radioelements of high specific activity are used, it usually gives a product of relatively low specific activity. Stable isotopes can similarly be used for the biological labelling of proteins; for example, nitrogen-15 has been used to label antibodies[8].

During the past few years, many investigators who wanted to use labelled proteins for biological tracer studies have consulted us with regard to the labelling methods we have used in our immunological investigations. Short accounts of some of our methods have been published[9], but a more complete account is given here in the hope that it will prove generally useful.

Labelling of Proteins with Iodine-131

The method we have used is essentially that described by Wormall[10]. The protein in ammoniacal solution is treated with a radioactive iodine solution prepared by one of the methods outlined below. The labelled protein is then freed from unbound or loosely attached iodine and iodide by dialysis, usually followed by precipitation by sodium sulphate or some other suitable salt

By this method proteins may be 'trace-labelled', that is, iodinated to a small extent (less than 1 per cent) with radioactive iodine of fairly high specific activity, so that they suffer little change in serological and other physico-chemical properties but can still be determined in minute amounts by radioactivity measurements Proteins may also be 'fully iodinated' (up to about 10 per cent iodine) to give labelled antigens for the study of iodinated protein antigen–antibody reactions The experimental procedures in 'trace-labelling' and 'full iodination' differ, and hence are dealt with separately below

Preparation of Radioactive Iodine Solutions

The amount of iodide in the 'carrier-free' sodium iodide solution containing iodine-131 normally supplied is negligible, in a chemical sense, and dilution with non-radioactive iodine is usually required The most convenient reagent for the iodination of proteins is a solution of iodine in potassium iodide (that is, $I_2 + KI = KI_3$) When sodium iodide containing iodine-131 is added to such a system, it takes part in the 'iodine–iodide' equilibrium and is rapidly distributed throughout the system From the point of view of obtaining maximal utilization of the iodine-131, the amount of potassium iodide present should be kept to a minimum, and either of two methods can be used for the preparation of suitable solutions of iodine in potassium iodide

(i) *Saturation of a potassium iodide solution with elementary iodine.* The potassium iodide solution is treated with excess of finely powdered iodine, allowed to stand for about 48 hr with occasional shaking, and then filtered to remove excess of solid iodine The amount of free iodine in this solution is then determined by titration with standard thiosulphate By choosing an appropriate concentration of potassium iodide, a solution of iodine in potassium iodide of any desired concentration may be prepared For this purpose it is useful to draw a graph showing the solubility of iodine in solutions of varying concentration of potassium iodide at the appropriate temperature The iodine-131 (as sodium iodide solution) is added to the iodine (in potassium iodide) solution a few minutes before use for iodination

(ii) *Liberation of iodine from an 'iodide–iodate' mixture containing sufficient excess of iodide* The quantity of iodine required is calculated and liberated according to the equation

$$5KI + KIO_3 + 6HCl = 6KCl + 3H_2O + 3I_2 \qquad (1)$$

An excess of potassium iodide (determined from the graph) just sufficient to keep the liberated iodine in solution is used The radioiodine solution may be added to the original potassium iodide, or to the solution after the liberation of iodine

(One disadvantage in the use of solutions of iodine in potassium iodide is that the iodine-131 present as iodide, usually about half the total, takes no part in the iodination If supplies of iodine-131 are limited, this loss of radioactive materials can sometimes be largely avoided by iodinating with a solution of iodine in ether The quantity of iodine required is calculated and prepared according to equation (1), using no excess of potassium iodide, the radioactive iodine (as iodide) being added to the potassium iodide used The liberated iodine is extracted with ether (s g 0 720, previously twice washed with distilled water) to give a solution of radioactive iodine in ether This method has been found useful for the preparation of radioactive 3 5-diiodotyrosine, but it is not generally satisfactory for the iodination of proteins, since ether has a denaturing effect on many proteins)

'Trace-labelling' of Proteins with Radioactive Iodine

The iodination of proteins in ammoniacal solution proceeds smoothly at room temperature The concentration of ammonia used can be varied within fairly wide limits, but in order to minimize the risk of damage to the protein, it is advisable to keep it fairly low. In the labelling of antibodies with iodine-131, we have used 0 10 ml 5*N* ammonium hydroxide per 1 0 ml protein solution

The radioactive iodine solution is added, a few drops at a time, to the ammoniacal solution of the protein, with shaking after each addition When all the iodine has been added, the solution is allowed to stand for 10–15 min and then brought to *p*H 7 5 with *N* acetic acid The labelled protein is best freed from unbound iodine and iodide by dialysis, followed by several precipitations with sodium or ammonium sulphate The solution is first transferred to a dialysis sac (Visking 'Cellophane' tubing 1 in diam) containing a small glass marble to facilitate mixing, and the sac tied at both ends The solution is dialysed overnight against a large volume of 0 9 per cent sodium chloride to remove most of the free iodide Final 'purification' of the labelled protein can be effected by several precipitations, for example, globulins with sodium sulphate (a final concentration of 12 per cent for gamma-globulins, 18 per cent for total globulins), and albumins by saturation with ammonium sulphate

The amount of iodine required to be added to give any particular degree of iodination is readily calculated from the fact that in the introduction of small amounts of iodine (up to 1 per cent) by this method, about 35 per cent of the added free iodine combines with the protein

Table 1 IODINATION OF ANTISERUM GAMMA-GLOBULINS

γ-Globulin solution (2 5 per cent protein) (ml)	5*N* ammonium hydroxide added (ml)	Radioiodine solution (*X*) added (ml)	Amount of free iodine (mgm)	Iodine content of labelled γ-globulins (per cent)
1 0	0 1	0 275	0 225	0 32
1 0	0 1	0 55	0 45	0 60
1 0	0 1	0 92	0 75	0 87

Example 0 01 *M* potassium iodide solution was treated with excess of finely ground iodine, the mixture kept for 30 hr and then filtered A 4 0-ml sample of this solution of iodine in potassium iodide, containing 1 23 mgm free iodine/ml, was mixed with 2 0 ml of radioactive 'carrier-free' sodium iodide (containing 100 μC of iodine-131) This mixture (*X*), containing 16 7 μC of iodine-131 and 0 82 mgm free iodine/ml, was then used to iodinate the gamma-globulin fraction of an antiserum obtained by immunizing rabbits with ovalbumin treated with mustard gas sulphone Typical results of this experiment are given in Table 1

'Full Iodination' of Proteins with Radioactive Iodine

A higher concentration of ammonia than that used in 'trace-labelling' is necessary for full iodination by this method We normally use 0 5 ml 5*N* ammonium hydroxide per ml. protein solution (2–3 per cent protein). In preparing a fully iodinated protein, the iodine solution may be added dropwise to the ammoniacal solution of the protein until free iodine is detectable, by starch, a few minutes after the last addition. With radioactive iodine, it is more economical to add a calculated amount of the iodine solution, and we have found that 30–35 mgm. iodine added per 100 mgm. protein gives fairly complete iodination of serum proteins and ovalbumin under these conditions. These fully iodinated proteins can be 'purified' by several reprecipitations by acid. Dilute acetic acid is added to give maximal precipitation and the mixture is centrifuged. The precipitate is dissolved in 0·9 per cent sodium chloride with dilute sodium hydroxide or sodium carbonate solution added to give *p*H about 7·5. The precipitation with acetic acid is repeated a further two or three times.

Example. 150 μC. of iodine-131 (as sodium iodide solution) was added to a mixture of 0·4 ml. of 10 per cent potassium iodide and 1·43 ml. of 0·1 *N* potassium iodate, and the iodine was then liberated by adding a slight excess of 0·1 *N* hydrochloric acid. This solution was then added, a few drops at a time, to a mixture of 1·0 ml. of a 5 per cent solution of human serum globulins, 1·0 ml. of water and 1·0 ml. of 5*N* ammonium hydroxide. After the mixture had stood at room temperature for 5 min., the iodinated globulins were freed from unbound iodine and iodide by three precipitations in slightly acid solution, as described above. These iodinated globulins contained 9·2 per cent of iodine (based on an average nitrogen content of 16 per cent for the serum globulins), and they gave the following rate of counts: 200 counts/min./μgm. protein nitrogen with the liquid counter described by Veall[11], and 2,000 counts/min./μgm. protein nitrogen with an end-window bell-type counter.

Discussion

For our immunological investigations, we have found the labelling of antibodies and antigens with iodine-131 very satisfactory. Where 'trace-labelling' is adopted, there is little detectable change in the properties of these compounds; for example, precipitating antibodies can be labelled with appreciable amounts of iodine without significant loss of their precipitating power. Some typical results of our experiments with iodinated antibodies are given in Table 2, and from these results it will be seen that no marked reduction in the amount of precipitable antibody occurs until an average of about 1 per cent of iodine has been introduced into the antibody. This corresponds to an average introduction of about 13 atoms of iodine, or the formation of 6·5 diiodotyrosine groups, per molecule of antibody (assuming an average molecular weight of 165,000 for antibody molecules).

Labelled proteins containing appreciably less than 1 per cent iodine can be used for immunological and many other biological investigations. There are, however, certain drawbacks to the use of a preparation which is likely to contain a high proportion of unlabelled protein molecules, since the possibility of the iodinated protein behaving differently from the original protein cannot usually be excluded. Butement[12] has calculated that where an average of 7·7 atoms of iodine are introduced into each molecule of a protein, corresponding to an iodine content of about 0·60 per cent for antibody molecules, it is probable that only 0·05 per cent of the molecules will be unlabelled. (This calculation is based, however, on the assumption that single atoms of iodine enter the protein molecule, whereas the main change is the formation of 3 5-diiodotyrosine residues.) The introduction of 1 per cent or more iodine into the precipitating antibodies we have studied leads to marked loss of their precipitating power (Table 2), and this is in agreement with the results obtained by Breinl and Haurowitz[13] in their studies on the action of ordinary iodine on agglutinating antisera.

Table 2. Effect of iodination on precipitating antibodies

The antiserum used in this experiment was obtained by immunizing rabbits with 'sulphone-ovalbumin' (ovalbumin treated with di-2-chloroethylsulphone), and the antibodies (the separated γ-globulin fraction of this antiserum) were labelled with iodine-131. The 'sulphone-ovalbumin' used as antigen in the precipitin tests was labelled with sulphur-35, to allow a complete analysis of the precipitates to be made. The antibody nitrogen in each precipitate was determined in two ways: (*a*) from iodine-131 contents, and (*b*) by subtracting the antigen nitrogen (calculated from the sulphur-35 content) from the total nitrogen; the two methods gave essentially the same result in every case

Iodine content of iodinated γ-globulins ('antibodies')		Precipitate formed (per ml. of antiserum) in the region of maximum precipitation	
(per cent)	atoms/mol. of protein	Total N (μgm.)	Antibody N (μgm.)
0	0	107	99
0·33	4·3	109	100
0·65	8·4	102	92
1·17	15	88	83
2·51	33	36	34

In recent years several other investigators have labelled proteins with iodine-131, usually by adding iodine in potassium iodide solution to a slightly alkaline solution of the protein. Pressman and Keighley[14] have, for example, iodinated, with iodine-131, antisera to kidney extracts and have used them to study the localization of these antibodies in the kidney after their injection into rabbits. More recently, Pressman and Sternberger[15] have extensively studied, by immunochemical methods, the relative rates of uptake of iodine by various serum proteins when antisera are iodinated by iodine in potassium iodide solution in a borate buffer at *p*H 8. They found that the albumin fraction becomes iodinated twice as rapidly as does the total globulin fraction, and the latter twice as quickly as antibody molecules. They also found that the introduction of as many as eighteen iodine atoms per antibody molecule does not destroy its ability to undergo specific precipitation. Other investigators[16] have used iodinated proteins containing iodine-131 to study the distribution of injected antigens.

Labelling of Proteins with Phosphorus-32

Proteins can be labelled *in vitro* with phosphorus-32 by treating the protein with phosphoryl chloride, and the phosphorylated proteins obtained can be used in certain immunological experiments[17] and possibly other investigations. However, treatment with this reagent effects considerable changes in the chemical, physical and immunological properties of serum proteins, ovalbumin, etc.[18], and furthermore, many of the attached phosphate groups are readily split off when the labelled protein is injected intravenously into a rabbit. Thus phosphorylated proteins have rather a limited value in biological tracer investigations, though the use of very small amounts of phosphoryl chloride prepared from radiophosphorus of high specific activity might yield 'trace-labelled' phosphorylated proteins useful for short-term tracer experiments.

Labelling of Proteins with Sulphur-35 (using Mustard Gas Sulphone)

Most proteins readily react with mustard gas sulphone at pH 7 5–8 0, and the 'sulphone-proteins' obtained from the serum proteins and ovalbumin can be 'purified' by precipitation with dilute acetic acid By using mustard gas sulphone containing sulphur-35, labelled proteins suitable for some immunological and other purposes can be obtained[2,3], but it must be remembered that these proteins are 'foreign' to the animal body When injected into an animal they usually incite the formation of antibodies specific for 'sulphone-proteins', and they thus have a limited value for ordinary tracer investigations

Recently, we have prepared radioactive mustard gas sulphone of high specific activity, and have labelled ovalbumin with this reagent Proteins trace-labelled with sulphur-35 in this way should be generally useful, since all our evidence tends to show that the sulphone groups are firmly attached to the protein molecule and are not readily removed *in vivo*

Double Labelling of Proteins with Iodine-131 and Sulphur-35

Red cells can be labelled with two radioactive isotopes of iron, and the biological double-labelling of other proteins such as casein, nucleoprotein or lipovitellin with two or more different isotopes presents no insuperable difficulty Multiple isotopic labelling of proteins, with all the labels firmly attached to the protein molecule, is, however, not so readily achieved by purely chemical methods without appreciable alteration in the chemical and physical properties of the protein

During the past two years we have studied the labelling of ovalbumin and serum globulins with both iodine-131 and sulphur-35 These double-labelled proteins have proved useful in our study of the specific combining properties of the antibodies produced in response to the injection of the double-labelled antigens[19], and it is possible that the methods we have used may be suitable for other biological studies We have found that the most satisfactory labelling is usually obtained if the treatment of the protein with mustard gas sulphone precedes iodination, for, in general, iodination of ovalbumin or serum globulin appears to reduce the reactivity of the protein towards mustard gas sulphone A typical example of the technique is given below It should be emphasized, however, that the double-labelled proteins obtained are 'chemically-altered', and have chemical and immunological properties significantly different from those of the corresponding unlabelled proteins

Example Mustard gas sulphone (177 mgm) and one drop of phenol red solution were added to 10 ml of a 6 5 per cent solution of thrice-crystallized ovalbumin and the mixture was stirred at 37° for 2 hr, with 5N sodium hydroxide added when necessary to keep the pH at 7 5–8 0 The solution was then kept overnight at 37°, filtered, and treated with 2N acetic acid to give maximal precipitation The precipitated 'sulphone-ovalbumin' was dissolved in water with the aid of a little dilute sodium hydroxide and again precipitated by adding acetic acid After a further precipitation, the solution (10 ml , pH about 7 5) was treated with 5 0 ml of 5N ammonium hydroxide and the protein iodinated by adding 5 0 ml of 0 1N iodine in potassium iodide The 'iodinated-sulphone-ovalbumin' was precipitated by adding acetic acid, reprecipitated a further twice, and dissolved in 10 ml of 0 9 per cent sodium chloride at pH 7 5 This preparation of double-labelled ovalbumin contained 18 5 atoms of iodine and 24 sulphone groups per molecule of protein (assuming a molecular weight of 40 500 for ovalbumin)

In other investigations we have used smaller amounts of mustard gas sulphone and iodine, both of high specific radioactivity, to effect 'trace double-labelling' of certain proteins Full details of the method, which is a slight modification of that described above, will be published later

Summary

The labelling of proteins with iodine-131 can readily be effected by iodination in weakly ammoniacal solution In this way proteins can be 'trace-labelled' without serious alteration in their chemical and physical properties, or more fully iodinated proteins can be prepared Proteins labelled with phosphorus-32 prepared by treating the protein with phosphoryl chloride have a limited use for most biological investigations, but those labelled with sulphur-35 (by the use of mustard gas sulphone) are very suitable, since the attached sulphone label is not readily removed *in vivo* A brief account is given of double isotopic-labelling of proteins, with iodine-131 and sulphur-35

We are indebted to the Medical Research Council and the Central Research Fund of the University of London for grants (to A W) covering part of the expenses of these investigations We are also grateful to Dr K Zerahn, who collaborated with us in the preparation of some of the double-labelled proteins, and to Dr V C E Burnop for help with one of the preparations of radioactive mustard gas sulphone

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OBITUARIES

Dr. Robert Broom, F.R.S.

Dr. Robert Broom, who died on April 6 at the age of eighty-four, was distinguished not only for the great abundance of his contributions to the science of palæontology, but also for the wealth of evidence which they provided in connexion with some of the most interesting problems of vertebrate evolution. Broom was born in 1866 and studied medicine at the University of Glasgow. He qualified in 1889, after first serving an apprenticeship in the Department of Chemistry as a junior assistant. It was during this interlude that his first scientific paper, "On the Volume of Mixed Liquids", appeared in the *Proceedings of the Royal Society of Edinburgh*. However, the current interest in evolutionary problems soon attracted him into the biological field, and he became particularly occupied with the question of the origin of mammals. Indeed, it was partly for this reason that in 1892 he went to Australia, for he sought opportunities for making embryological studies on monotremes and marsupials.

During the next few years Broom published a number of papers on morphological subjects, including several dealing with the structure of the skull, the vomero-nasal organ, and the development of the vertebrate skeleton. The main theme of these contributions concerned the establishment of homologies in mammals and reptiles as a basis for a discussion of phylogenetic relationships. While on a visit to London in 1897, Broom's interest was aroused by the cynodont skulls collected by Dr. H. G. Seeley in South Africa, and it was this which stimulated him to go to Cape Town in order to make further studies of the fossil remains of these mammal-like reptiles. He engaged in a modest medical practice which permitted him from time to time to make fossil-hunting expeditions to the Karoo, and for a few years he also occupied the chair of geology and zoology at Victoria College, Stellenbosch.

There followed a most productive period of some twenty years during which Broom published a succession of papers on the mammal-like reptiles, as well as many dealing with the anatomy and taxonomy of the Chrysochloroidea and other groups of recent mammals. In 1913 he was invited to give the Croonian Lecture of the Royal Society, choosing as his subject "The Origin of Mammals". In 1920 he was elected a Fellow of the Royal Society and in 1928 awarded one of the Royal Medals. These honours, supplemented later by the conferment of honorary degrees by several universities, bear witness to the respect and admiration aroused by his scientific work. In 1932 Broom's intensive studies of the material collected in the field by himself culminated in the publication of a large monograph entitled "The Mammal-like Reptiles of South Africa". Apart from the discovery of many new types, he made a detailed study of the Pelycosauria. He was the first to show that these were 'mammal-like reptiles', firmly establishing their phylogenetic status in relation to the origin of the Mammalia. He also made valuable contributions to the major classification of the Reptilia.

In 1934, at the personal instigation of the late Field-Marshal Smuts, Broom was given an appointment on the staff of the Transvaal Museum, Pretoria. It was soon after this that, convinced of the importance of the Taungs skull (*Australopithecus*) in relation to the problem of the origin of man, he sought for further remains of these extinct ape-like creatures. His long experience in the field enabled him, with the most remarkable insight, to recognize other sites which might be expected to yield fossil fauna similar to Taungs, and within a few years he had made a most amazing collection of australopithecine material at Sterkfontein and Kromdraai, only a few miles from Pretoria. The results of these excavations were published in two monographs in 1946 and 1950. Soon afterwards, an even richer deposit was found at another site, Swartkrans, about a mile from Sterkfontein, and here Broom found (with the help of his assistant, Mr. J. T. Robinson) many more skulls, jaws, teeth, and portions of the limb skeleton, including those of adults, adolescents and infants. At the time of his death, he had just completed his manuscript for a monograph on this new material.

Although the major part of Broom's long scientific career was spent on a study of mammal-like reptiles, his name at the moment happens to be associated in the minds of most people with the fossil Australopithecinæ, because of their topical interest. His work established clearly that the importance of these fossils lies in the remarkable combination of simian and hominid features which they present. It is true to say that this is now generally recognized, even though the precise taxonomic significance of the hominid characters has been a subject of controversy. Although he allowed himself the privilege of speculating in his popular expositions, in his scientific communications Broom actually expressed himself rather cautiously about the position of the Australopithecinæ; he took the view that they either represent branches of the ancestral stock which gave rise (perhaps at an earlier time) to *Homo*, or that at least they were probably rather closely related to this stock. Following his outstanding work on this fossil material, Broom received two honours which gave him very great pleasure, the Wollaston Medal of the Geological Society of London, and the Elliot Gold Medal awarded by the United States National Academy of Sciences. The citation of the latter refers to Broom's monographs on the Australopithecinæ as a scientific contribution to the study of fossil man "of the foremost rank".

Those who knew Broom personally were impressed by his indefatigability, for he possessed an astonishing combination of mental and physical energy. If the pace at which he worked sometimes gave to passing acquaintances an impression of impatience, and perhaps on occasion even a suggestion of impetuosity, this was but an expression of a most impelling enthusiasm which animated all his activities. This enthusiasm showed no signs of waning up to the very end of his life. Indeed, the last few years of his long life were just as productive as any equivalent period in the early part of his career. Probably few octogenarian men of science could claim as much.

W. E. Le Gros Clark

Prof. G. A. R. Kon, F.R.S.

British chemistry has lost a unique personality in the sudden death on March 15 of George Armand Robert Kon, professor of chemistry at the Chester Beatty Research Institute of the Royal Cancer Hospital. George Kon was born in 1892 in St. Petersburg, having a Polish father and a French mother. His early education was in Russia, Tientsin and Vladivostok. At the suggestion of Sir Robert Hodgson he was sent to the University of Cambridge, where he obtained a second class in the Natural Science Tripos in 1912 In 1913 he joined the Imperial College of Science and Technology, London, where he was a contemporary of S Sugden and C K Ingold, and started research work under J F (later Sir Jocelyn) Thorpe He was naturalized in 1916 and served in the anti-gas service during the First World War, being a member of the British Gas Mission to the United States in 1918 He was mentioned in dispatches in 1917 At the end of the War he rejoined Thorpe at the Imperial College He received the D Sc in 1922, became lecturer in organic chemistry in 1925 and assistant professor in 1934 In 1942 he was appointed professor of chemistry at the Chester Beatty Institute, a post which he held until his death He was elected a Fellow of the Royal Society in 1943

Kon's scientific career falls into three parts The first, up to about 1932, was taken up with the study of tautomerism, particularly the classical work on the migration of the double bond in unsaturated chains Conspicuous in this period was his work on the glutaconic acids In the next decade he worked most effectively in the steroid and triterpene groups He synthesized the key dehydrogenation product of the steroids, 'Diels' hydrocarbon', and later made important contributions to triterpene chemistry The final phase came after his appointment to the Chester Beatty Institute, where he was concerned with new types of chemical carcinogens, including aminostilbenes, 'nitrogen mustards', epoxides and other biological alkylating agents This work shows promise of throwing light on the mechanism of carcinogenesis and mutagenesis Throughout his career Kon was a most gifted experimentalist, with an assured and masterly technique

He was a man of unusually wide tastes and accomplishments, an excellent linguist, an admirable golfer and a lover of fine furniture But he will be best remembered for his entirely lovable personality which embodied modesty, humour, kindliness and great generosity

R P LINSTEAD

Dr John S Paraskevopoulos

DR J S PARASKEVOPOULOS, astronomer in charge of the Boyden station of the Harvard Observatory at Bloemfontein, died after a short illness on March 15 last at the age of sixty-one He will be specially remembered for his work in superintending the taking of photographs of the southern skies, which enabled the Harvard astronomers to study the whole of the sidereal universe and not merely that part which appeared above the local horizon

"Paras", as he was often called, studied astronomy in his native Greece and, for a short time, worked at the National Observatory at Athens He saw military service in the Balkan Wars and the First World War, which prevented him proceeding abroad with a scholarship he had won in 1912 In 1919, however, he went to Yerkes Observatory of the University of Chicago, where he spent three years At Columbia University he met and married Miss Dorothy W Black, who accompanied him and took part in his future astronomical work The Harvard southern station had been erected in the 1890's at a high altitude at Arequipa in Peru, and when "Paras" was sent to take charge of it in 1923 it had been decided to seek another site, as the observing conditions at Arequipa, although excellent for most of the year, were poor from December to March This left part of the sky poorly observed, and Dr and Mrs Paraskevopoulos investigated other sites in Peru and northern Chile Reports from South Africa ultimately led to the selection of a site at Mazelspoort, about fourteen miles from Bloemfontein, at an altitude of 4,500 ft , and this site has proved an excellent one About the middle of 1927 the first instruments arrived in South Africa, and since then "Paras" was actively engaged in procuring photographs for the Harvard Programme

In all, ten telescopes were erected at Mazelspoort and have been continuously employed by some half a dozen assistants The instruments included a 60-in reflector, the 24-in Bruce doublet and smaller instruments down to 3-in and even 1½-in telescopes used as patrol cameras The work covered most fields of practical astrophysics—nebular surveys, proper motions, photometry, variable stars and spectroscopy Only a few months ago, a powerful Baker–Schmidt reflector was added to the equipment The number of plates taken in a month sometimes exceeded a thousand

The time of Dr Paraskevopoulos was mostly taken up in practical work, and he had little time for personal research He was specially interested in nebulæ and clusters, and as president of the Astronomical Society of South Africa gave his presidential address in 1938 on "The Transparency of Space and Absorbing Material" He naturally took great interest in special occasions such as the total solar eclipse of 1940 and the appearance of bright comets He will be much missed by his Harvard colleagues

Paraskevopoulos retained his Greek nationality, and during the War he and his wife were active in work for assisting Greek refugees in South Africa His astronomical work was recognized by his election as a member of the Greek Academy of Science

NEWS and VIEWS

Festival of Britain

"ONE hundred years ago Queen Victoria opened the Great Exhibition in Hyde Park Its creators were far-sighted men who looked forward to a world in which the advances of art and science would uplift civilization to enduring peace and prosperity " With these words, H M the King began his address from the steps of St Paul's Cathedral, when on May 3 he formally declared open the Festival of Britain He referred to the many parallel festivals up and down the country as a visible sign of national achievement and confidence, and he remarked "Many of these activities and displays will be of lasting value They will maintain the prestige of our arts and industries abroad by proof of our world-renowned skill in design and craftsmanship, and they will also show how vital a part is played in industry by scientific imagination and research " Another aspect of the past hundred years was stressed by the Archbishop of Canterbury in his address at the ceremony of dedication which preceded the King's speech He said "The greatest creation of our nation has been a way of life, a tradition of how men and women and children may live together in the freedom of mutual respect and trust, free to be themselves, free to be generous to others "

So the Festival of Britain has opened Many eminent men of science have given much thought and time to the scientific displays, and reference was made to this by the Lord President of the Council in his message published in *Nature* of May 5 He also pointed out that scientific workers generally have still a special part to play in the Festival They alone can work for the better relationship between science and the community—for wider understanding of the methods and purpose of science The achievement of this understanding will be an important step towards the fulfilment of the prayer with which the King concluded his address, that "the vast range of modern knowledge may be turned from destructive to peaceful ends, so that all peoples, as this century goes on, may be lifted to greater happiness"

Chemical Engineering at University College, London : Prof H E Watson

PROF H. E WATSON will retire from the Ramsay chair of chemical engineering in University College, London, at the end of the present session Educated at Marlborough and University College, where he came under the influence of Sir William Ramsay, Prof Watson had a most distinguished college career Awarded an 1851 Exhibition in 1909, he gained further experience in research in the Universities of Berlin, Geneva and Cambridge, working for a time in the Cavendish Laboratory, Cambridge In 1911 he was selected by his former teacher, Dr M Travers, who had recently been appointed director of the Indian Institute of Science, Bangalore, to be assistant professor of inorganic and physical chemistry This post he held until 1916 when, on the retirement of Dr Travers, he was appointed to the chair Although Prof Watson's main interests lay in physical chemistry, to which subject he has made valuable contributions, he collaborated with his colleague, Prof J J Sudborough, in the study of Indian natural products likely to prove of economic value With their students they published a long series of important papers on Indian vegetable and essential oils One outcome of this work was the establishment of the Mysore Government Factory for the distillation of sandalwood oil Many of Prof Watson's students now occupy important positions in Indian universities and industry On returning to Great Britain in 1934, Prof Watson was appointed to his present chair With the outbreak of the Second World War in 1939, his services were placed at the disposal of the Admiralty, and on his return to the College in 1945 he was faced with the problem of rebuilding and refitting his laboratory, which had been destroyed by enemy action There is little doubt that under more favourable conditions Prof Watson would have made an even more valuable contribution to the training of chemical engineers than he has done

Mr M B Donald

MR MAXWELL BRUCE DONALD, who has been appointed to succeed Prof Watson, was born in 1897 and educated at Felsted School He entered the Royal College of Science, London, in 1914, but his university career was interrupted by the First World War, in which he served in France as a lieutenant in the Royal Artillery Returning to London at the end of the War, Mr Donald obtained the associateship of the College with a first class in chemistry and was awarded a Yarrow Scholarship for study in the United States, where he worked at the Massachusetts Institute of Technology and obtained his first taste for chemical engineering He was elected an associate member of the newly formed Institution of Chemical Engineers in 1923, and, after two years of teaching, he spent three years in Chile investigating problems of nitrate production In 1931 he was appointed a lecturer, and in 1947 reader, in chemical engineering at University College, London Mr Donald is probably best known to his wide circle of friends as the honorary secretary during 1937–49 of the Institution of Chemical Engineers ; he is now a vice-president of the Institution, a member of council of the Royal Institute of Chemistry, member of the Chemical Council, director of the Bureau of Abstracts, chairman of the Maximum Permissible Working Stress Committee of the British Standards Institution, and a member of many other committees In these varied capacities he has rendered services of the greatest value to chemical engineering, especially on the educational side He was mainly responsible for drafting the scheme for an undergraduate course in chemical engineering, which forms the basis of teaching in many universities throughout the British Commonwealth, and has more recently prepared a much-wanted syllabus for higher national certificates These activities have not prevented his writing numerous scientific papers and reports of considerable importance, including two recent memoirs of a historical nature In his new post Mr Donald will have ample opportunity to continue this good work, and the profession will look forward to his help and guidance in the future

Applied Mathematics at Queen's University, Belfast : Mr D R Bates

MR D R BATES, at present reader in physics in University College, London, has been appointed to the chair of applied mathematics in Queen's University, Belfast Mr Bates is a graduate of Queen's University, where in 1937 he took the degree of B Sc with first-class honours in mathematical physics and experimental physics, and in 1938 the degree of M Sc in mathematical physics After a short period as a research student at University College, London, under Prof H S W Massey, he was engaged in research for the Admiralty until 1945 Since then, apart from a visit to the United States in 1950, he has been again at University College Mr Bates's research has been mainly directed to the application of quantum mechanics to the study of atomic structure and the rates of atomic processes, and in particular to those problems which have a bearing on the properties of the upper atmosphere and similar diffuse systems He has published a large number of important papers on these subjects and is a recognized authority on the physics of the ionosphere, as well as an important contributor to astrophysical subjects In particular, his paper on the "Intensities of Spectral Lines" should prove of much value to astrophysicists During the Second World War Mr Bates was concerned mainly with the defensive and offensive aspects of sea mining warfare, and his work led to much economy in the difficult technique of design of mine mechanisms for resisting the shocks inherent in mine laying

Samuel George Morton (1799–1851)

A CENTURY ago, on May 15, 1851, Samuel George Morton, physician and naturalist, died in Philadelphia at the age of fifty-two Born in 1799, he graduated M D at the University of Pennsylvania in 1820, and, after studying in Europe, obtained the M D of the University of Edinburgh three years later In 1839 he was elected to the professorship of anatomy in Pennsylvania College, and his substantial "Human

Anatomy" gained him a lasting reputation. Within the field of medicine he was noted for his work on tuberculosis; he considered bronchitis to be a contributory factor in the causation of the disease and was an early advocate of open-air treatment. His book, "Illustrations of Pulmonary Consumption", was published in 1834. Morton also made notable contributions to geology, zoology and vertebrate palæontology. His "Synopsis of the Organic Remains of the Cretaceous Group of the United States" (1834) described fossils brought back by the Lewis and Clark Expedition and may be considered the starting point of palæontological and systematic work on American fossils. An earlier work dealt with numerous fossil forms—plesiosaurs, crocodiles, horses, elephants and mastodons—found near the Raritan River, New Jersey. For purposes of comparative study he assembled a large series of human skulls; the collection was said to have cost him between ten and fifteen thousand dollars, and to be "worth a visit to America". For his conclusion that the races of man were of diverse origin he was bitterly assailed by many who claimed that he was denying the authority of the Scriptures.

History of Sources of Energy

THE latest science pamphlet in the fortnightly series published by the Bureau of Current Affairs has been written by William E. Dick, the editor of *Discovery*, and describes the development of sources of energy from early times. Beginning with the use of man's own energy, Dick examines the employment of animals, wind and water mills, steam and iron, the development of railways and ships, the growth of electricity and the origin of the steam turbine and the internal combustion engine, the first aircraft, and the invention of the gas turbine. Water and tidal power, the wind, heat of the sea, geothermal and solar energy are discussed as other possible sources of power, while, in another section, the author discusses the efficient use of fuel before examining the source and potentialities of atomic power. Like the majority of these pamphlets, "The Story of Energy" is admirably illustrated with attractive and topical diagrams and illustrative charts and maps. It also contains a lucid summary and relevant bibliography.

Royal Commission on University Education in Dundee

A ROYAL Commission has been set up to inquire into the organization of university education in Dundee. Its terms of reference are: "To inquire into the organization of university education in Dundee and its relationship with St. Andrews University, and to recommend what changes, if any, should be made in the constitution, functions, and powers of the University of St. Andrews, of University College, Dundee, or of any other body or institution concerned". The Commission consists of Lord Tedder (*chairman*), Lord Greenhill, Sir David Lindsay Keir, Prof. Dugald Baird, Mr. David Emrys Evans, Mrs. Isabel Finlayson, Prof. H. W. Melville, Mr. J. S. Muirhead and Mr. Andrew Robertson. The secretary of the commission is Mr. N. J. P. Hutchison, of the Scottish Home Department; communications should be addressed to him at the office of the Royal Commission, 12 Carlton Terrace, Edinburgh, 7.

Royal Geographical Society: Awards

THE King has approved the following awards of the Royal Medals of the Royal Geographical Society: *Founder's Medal* to Dr. V. E. Fuchs, principal scientific officer, Falkland Islands Dependencies Survey scientific bureau, Colonial Office, for his contributions to Antarctic exploration and research as leader of the Survey, 1948–50; *Patron's Medal* to Dr. Donald Thomson, research fellow, University of Melbourne, for geographical exploration and studies in Arnhem Land.

The Council has made the following awards: *Victoria Medal* to Dr. C. A. Cotton, professor of geology, Victoria University College, New Zealand, for his contributions to the geomorphology of New Zealand; *Murchison Grant* to Dr. George Salt, Fellow of King's College, Cambridge, for geographical studies of the Shira Plateau of Kilimanjaro; *Back Grant* to Mr. J. N. Jennings, lecturer in geography, University College, Leicester, for his work on the origins of the Broads; *Cuthbert Peak Grant* to Mr. W. B. Harland, lecturer in geology, University of Cambridge, for surveys and mapping in central West Spitsbergen; *Gill Memorial* to Dr. W. R. Mead, lecturer in geography, University College, London, for geographical research in Finland.

Institution of Mining and Metallurgy: Awards

THE Institution of Mining and Metallurgy has announced the following awards: *Honorary Membership of the Institution*: Sir Henry Tizard, in recognition of his outstanding services to science, industry and education; and Sir Andrew Bryan, H.M. chief inspector of mines, in recognition of his distinguished services to the mining industry of the United Kingdom. *Consolidated Gold Fields of South Africa, Limited, Gold Medal* for 1950, jointly to J. P. Norrie and W. T. Pettijohn for their paper on "An Outline of Underground Operations at Mufulira Copper Mines, Ltd." (*Trans.*, 59). *Consolidated Gold Fields of South Africa, Limited, Premium* (forty guineas) for 1950, jointly to H. L. Talbot and H. N. Hepker for their paper on "Investigations on the Production of Electrolytic Cobalt from a Copper–Cobalt Flotation Concentrate" (*Trans.*, 59). *William Frecheville Students' Prize* to G. J. Mortimer for his paper on "Grade Control" (*Trans.*, 59).

Iron and Steel Institute: Medals and Prizes

THE following Medals and Prizes of the Iron and Steel Institute have recently been awarded: *Bessemer Medal* for 1951 to Benjamin Fairless, president of the United States Steel Corporation, in recognition of his distinguished services to the iron and steel industry; *Sir Robert Hadfield Medal* for 1951 to William Barr for his contributions to research in steelmaking; *Andrew Carnegie Silver Medal* for 1950 to A. B. Winterbottom for his report on "Optical Studies of the Oxidation of Iron at Temperatures in the Range 20–265° C."; *Williams Prize* for 1950 jointly to T. H. Harris and W. H. Everard for their paper on "The Use of the Oxygen Lance in British Electric Furnace Practice" (their co-author, D. J. O. Brandt, is not eligible to participate in the Prize); *Ablett Prize* for 1950 jointly to D. A. Wise and Dr. L. N. Bramley, for their paper on "Proposed Method of Specifying Travel-Motion Performance for Steelworks Overhead Cranes".

Royal Institution: Officers

AT the anniversary meeting of the members of the Royal Institution, held on May 1, the following officers were elected: *President*, Lord Brabazon of Tara; *Secretary*, Prof. A. O. Rankine; *Treasurer*, Dr. R. E. Slade; *Managers*, Dr. P. Dunsheath, Sir

Alfred Egerton, Sir William Halcrow, Mr O W Humphreys, Capt H L Hitchins, Dr R Lessing, Dr D C Martin, Prof L C Martin, Sir Thomas Merton, Mr A J Philpot, Mr J W Ryde, Sir John Simonsen, Mr Frank Wakeham, Dr O H Wansbrough-Jones and Mr G A Whipple , *Visitors*, Sir Wallace Akers, Mr F G Brown, Sir Ernest Rock Carling, Mr A D R Caroe, Mr K S Carpmael, Mr J F Coales, Dr A T Fraser, Prof Kathleen Lonsdale, Mr Stanley Robson, Mr W E Schall, Dr L Simons, Dr P C Spensley, Dr Norman Stuart, Mr M T Tudsbery and Dr S Whitehead

Third World Petroleum Congress

The Third World Petroleum Congress will be held during May 28–June 6 in the Kurhaus and the Palace Hotel, Scheveningen, Netherlands (with the opening ceremony in the Ridderzaal, The Hague), under the presidency of Jonkheer O C A van Lidth de Jeude, president of the Royal Netherlands Institution of Engineers The aim of the Congress is the discussion of all technical subjects concerning the petroleum and allied industries, and to this end it will be divided into the following sections (1) geology and geophysics , (2) drilling and production , (3) physical operations in oil processing , (4) oil processes involving chemical conversions , (5) production of chemicals from petroleum, and their properties and applications , (6) measurement and control, analysis and testing, and composition of petroleum , (7) utilization of oil products , (8) construction of equipment, and materials and corrosion , (9) transport, storage and distribution , (10) economics and statistics, documentation, and education and training At these sectional meetings neither papers nor summaries will be read, but instead a *rapporteur* will give a general introduction of 10–15 minutes in duration, with particular emphasis on points in the papers which will be suitable for discussion. Interpreters will be available for English-speaking and French-speaking delegates Further details can be obtained from the secretariat of the Congress at 30 Carel van Bylandtlaan, The Hague

Conference on Spectroscopy

A conference on spectroscopy will be held at Basle, Switzerland, during June 28–30 It will be divided into two main sections the first, presided over by Prof E Miescher, of Basle, will be on the "Experimental Study of Atomic and Molecular Spectra" , and the second, under Prof R Mecke, of Freiburg, on "Spectroscopy and Chemical Binding" This conference is privately sponsored, but all spectroscopists and others interested in this field are invited to participate , already a very wide attendance from all parts of the world, including Great Britain and the United States, is assured Those wishing to read papers should communicate as soon as possible with one of the following J Lecomte (Paris), Prof R Mecke (Freiburg i Br), Prof E Miescher (Basle), G Milazzo (Rome) or Dr H W Thompson (Oxford), from whom further particulars can be obtained

Chemistry in the Service of Man

In connexion with the Festival of Britain, to emphasize the outstanding part played by chemists in the cultural, industrial and economic advances of the past century, the Chemical Council has organized four public lectures on "Chemistry in the Service of Man" The lectures will be given by Prof R P Linstead, on "Chemistry and the Amenities of Life" (May 16, 3 p m) , Sir Jack Drummond, on "Chemistry and the Food We Eat" (May 23, 3 p m) , Prof J W Cook, on "Chemistry and the Conquest of Disease" (May 30, 6 p m) , Sir Cyril Hinshelwood, on "Chemistry and Modern Thought" (June 6, 6 p m) The lectures will be delivered in the Royal Institution, Albemarle Street, London W 1 Admission is free, by tickets obtainable from Ticket Secretary (Lectures), Chemical Council, 9–10 Savile Row, London, W 1

History of Pharmacy

An exhibition on "The History of Pharmacy", organized by the Wellcome Research Institution, was opened by Sir Howard Florey, professor of pathology in the University of Oxford, on May 8 at the Institution's headquarters, 183–193 Euston Road, London, N W 1, and will remain open to the public until September 28 (Mondays to Fridays, 10 a m –5 p m) The exhibition covers the whole field of the history of pharmacy from the earliest times to the beginnings of chemotherapy, and many rare books, prints and appliances are on show The first two sections illustrate respectively the period from antiquity to classical times, and from the Middle Ages to the end of the seventeenth century Succeeding sections deal with improvements in the manufacture of drugs , chemical discoveries of Priestley, Lavoisier and Dalton , development of organic chemistry , discovery of the alkaloids , introduction of anæsthetics , and development of experimental pharmacology A final section is concerned with modern practice Also at the Wellcome Research Institution there is a special exhibition for members of the medical and allied professions only on "The Illustration of Medical Books", which will be open (at the same times) until May 28 At the Wellcome Historical Medical Museum, at 28 Portman Square, Oxford Street, London, W 1, two current exhibitions, which are open to the general public, illustrate "Medicine in 1850" and "Prehistoric Man in Health and Sickness", and these are open until the end of May and June, respectively (Mondays to Saturdays, 10 a m –5 p m)

Announcements

H R H The Duke of Edinburgh has been admitted to the fellowship of the Royal Society

The degree of doctor of science *honoris causa* of the University of Oxford has been conferred on Prof J H Oort, professor of astronomy and director of the Observatory, Leyden, who is Halley Lecturer at Oxford this year

Honorary degrees conferred on May 1 by the University of Nottingham included the following D Sc Prof L Néel, professor of general physics in the University of Strasbourg , Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford , Sir George Stapledon, recently director of the Grassland Improvement Station, Ministry of Agriculture and Fisheries

The Senatus Academicus of the University of Edinburgh, on the recommendation of the Faculty of Medicine, has awarded the Cameron Prize in Practical Therapeutics for 1951 to Prof T Reichstein, professor of pharmaceutical chemistry, University of Basle, and Prof E C Kendall, professor of biochemistry, Mayo Foundation, University of Minnesota, "jointly in recognition of their fundamental researches leading to the discovery of cortisone"

COUNCIL FOR THE PROMOTION OF FIELD STUDIES

2. MALHAM TARN FIELD CENTRE

By P. F. HOLMES
Warden

MALHAM Tarn Field Centre is in fine wild Pennine country at a height of 1,300 ft., on the limestone uplands of Craven at the head of Airedale. To the young student from the south of England it is often a revelation simply to see such an expanse of uncultivated and sparsely populated country, to see high fells and steep valleys, and in the words of Prof. W. H. Pearsall, "to see man as part of a biological system rather than as the lord of his surroundings"; but to geography students of any age it is an area full of interest. About eight geography weeks are run, in spring and autumn mainly, during which study is made of the Great Scar limestone topography and karst phenomena, the underlying Palæozoics and the overlying Yoredale beds and Millstone grit, the Craven faults, glaciation, historical and present-day settlement and farming practice, soils and vegetation. These weeks are primarily for the 'sixth form', training college or independent student; university departments of geography usually send their own staff with students. Several university geological parties have studied at the Centre, and the Geological Association held its annual field meeting here in 1949. Courses in geology are now being conducted for the less advanced student.

Malham Moor, including the Tarn and Bog, is listed as an area of outstanding scientific value, within the proposed Yorkshire Dales National Park, in the report of the Wild Life Conservation Special Committee (Cmd. 7122, 1947); while the area from Malham Cove to Gordale Scar has also been recommended as a Geological Conservation Area for its typical limestone scenery and pre-Namurian fault-scarp.

The Tarn and 150 acres are leased by the Council for the Promotion of Field Studies from the National Trust, together with sporting rights over a further 9,000 acres of moorlands. The whole of this region is treated as a conservation area, to which students have access at all seasons, so that long-term research projects can be undertaken without interference, but in which 'vermin' such as foxes and crows are controlled. The vegetation offers fine opportunities for studying the ecology of a wide range of natural habitats, and more than half the university parties visiting the Centre have been botanists. There is the rich calcicolous flora of the limestone grassland, screes and pavements; native ashwood on pavements within reach; the moorland flora of the acid peat which blankets the gritstone fells and some of the overlying glacial drift; rough pastures with bents, matgrass and rushes; acid bogs and alkaline marsh leading to fen carr; reed swamp and the aquatic vegetation of the Tarn. The effects on plant communities of differences in the underlying rocks and soils, of leaching and flushing, grazing, altitude

[*Photo*: *E. Dudley C. Jackson*

Malham Tarn Field Centre

and climate can be clearly seen in this uncultivated area, which is also famous for its wealth of unusual species.

A series of peat borings taken across the 'moss' at the west end of the Tarn have shown this to be a raised bog at the inflow end of the old tarn, with up to 18 ft. of peat lying on marl and lake-clay deposits. Above the marl, sedge or fen peat is succeeded by a well-marked layer of brushwood peat, mostly silver birch; this is followed by a great thickness of *Sphagnum* peat and finally a surface layer of *Eriophorum–Calluna* peat with slight amounts of *Sphagnum*. On the north side of the present inflow stream there has been extensive peat cutting, and the artificial raising of the level of the Tarn in 1791 has caused much of this area to be flooded by alkaline water, producing a marsh vegetation leading to fen carr. It is hoped that pollen analysis will soon be undertaken both here and on the nearby blanket bogs of the fells. During 1950, several hundred students were introduced to the study of peat succession with a borrowed peat borer, during the course of plant ecology studies.

Malham Tarn itself is a shallow calcareous water of 153 acres which forms an excellent unit for freshwater studies; it has extensive beds of *Potamogeton*, *Myriophyllum* and *Chara*, and a shore-line ranging from exposed stones to sheltered sedge beds. It supports an abundant fauna of invertebrates and fish, with a total of species within the grasp of most students, so that time can be devoted to problems of population, distribution and food. Molluscs are abundant, and this is the highest recorded locality in Britain for some species such as *Limnæa stagnalis*, while *Hydrobia jenkinsi* appears to have colonized the Tarn during 1949 or 1950, and its spread is being watched. Regular collections of plankton and water samples have been taken since the Centre opened in 1948, and the annual changes are being studied by the staff of the Freshwater Biological Association at Windermere and at the Centre. The ecology of the Tarn, and comparison with the nearby Gordale Beck and acid peat pools, form a part of many of the biological weeks during the summer.

The water is an attraction to many types of birds, including large flocks of curlew which assemble near the shore from July to October, sometimes up to a thousand strong. Such inland flocking of the curlew seems to be unusual, but is a regular feature here. The planted woodlands around the Centre have an isolated population of birds on an otherwise rather treeless plateau, which makes it possible to have relatively complete censuses of selected species and to detect passage movements. But to the visiting ornithologist it is probably the breeding birds of the moorlands and streams which are the most interesting, such as golden plover, dunlin, grouse, ring ouzel, dipper, merlin and short-eared owl.

At this height one is bound to be extremely conscious of the weather, and the effects of climate on the distribution and activity of animals and plants is more pronounced than in lowland stations. The Centre has functioned for the past two years as an auxiliary meteorological station, the second highest in the British Isles, and by displaying the observations great interest is aroused in the study of the weather among visiting students. In 1950 the Royal Meteorological Society co-operated with the Council for the Promotion of Field Studies in running a pioneer meteorological course at Malham, and another is being held in September of this year.

In spite of the somewhat extreme climate on present-day standards, man has had a long and interesting history on these uplands of Malham Moor, and there are many visible remains of his dwellings or works still to be seen. Numerous flint implements of Mesolithic and Neolithic age are found, and there are abundant Iron Age hut circles and enclosures. During an archæological course conducted at the Centre by Dr. Arthur Raistrick in 1950, a Bronze Age barrow at Seaty Hill was excavated, with secondary Iron Age burials, and associated with one of the latter there was discovered a unique musical instrument made from part of a bone, similar to the modern recorder. It is possible to produce eight notes from this instrument, and a short recital on it was broadcast by the B.B.C. on February 9. Excavations were also made during the 1949 and 1950 courses of a site above the Tarn, which has proved to be a medieval farm building of the eleventh to thirteenth centuries. This yielded medieval pottery similar to that from the excavations at Almondbury, Huddersfield. In a nearby smaller building, a bronze disk and book trimmings were found in the lower parts, and these with the dimensions of the building indicate an earlier Anglian occupation of the sixth to eighth centuries, possibly a priest's 'cell'.

LOCATION AND DESTRUCTION OF LIPASE IN OATS

By DR. J. B. HUTCHINSON, H. F. MARTIN
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DURING the past four years, in a survey of the quality of British oats, we have analysed more than a thousand samples. In the case of the oil content, this has been found to vary between 4·5 and 11 per cent by weight of the dry matter of the kernel. The oil was extracted by petroleum ether and consists chiefly of unsaturated fats. In any one variety its value is represented by $M \pm 1$ per cent, but M varies from 10 per cent for Grey Winter and some of the Scotch Potato oat strains down to 5·5 per cent for Reliance.

In hand-shelled viable kernels or groats, 2–10 per cent of the oil is present as free fatty acids (calculated as oleic acid). In the normal storage of oats, for example, at 13 per cent moisture content and a storage temperature up to 18° C., the free fatty acid content increases only very slowly; but if the grain is crushed or milled into meal, the production of free fatty acid within two or three days is quite appreciable. Furthermore, this hydrolytic activity persists even if the normal oat oil is removed and replaced by other fats, for example, olive oil. Presumably the hydrolytic agent or catalyst is an enzyme of the lipase type, and, as would be expected, it is destroyed within a few minutes if the oat or meal is heated to a temperature of 90–100° C., provided their moisture content does not fall below about 12 per cent. This interplay of moisture content and temperature of inactivation of lipase is shown in the accompanying table, which gives over a range of moisture contents

Moisture content of groats (per cent)	Temperature
6	120° C.
8	104°
10	92°
12	83°
14	76°
16	71°
18	67°
20	64°

the temperatures required to inactivate 97–98 per cent of the lipase in one hour.

In our method of measuring lipase activity, the sample of meal is first defatted and neutral fat and water are added to the powdery residue. The free fatty acid formed per gram of defatted moisture-free meal is measured at intervals at constant temperature. The resulting curve follows very approximately the relationship

$$dy/dt = k_1(k_2a - y),$$

where y is the amount of fat hydrolysed in time t, a is the initial fat concentration, k_1 a velocity constant and k_2 another constant less than unity. The tangent at the origin of the curve, that is, k_1k_2a, is taken as a measure of the lipase activity of the meal. Furthermore, by measuring the free fatty acid formed in a fixed period of time, it is possible to compare the keeping qualities of different samples of oatmeal. We have found a period of three days at 12 per cent moisture content and 37° C. to be convenient conditions. Suitability for biscuit and oatcake manufacture can be satisfactorily assessed after 3 hr. incubation at 37° C. and 36 per cent moisture content.

Broadly speaking, oats for human consumption are sold either as oatmeal or oatflakes. Usually, in the manufacture of both products the oats are first kilned to dry them and also to facilitate dehulling; it may also impart a desirable flavour and aroma. During this kilning, the temperature of the oats frequently exceeds 90° C.; but by the time this temperature is reached the moisture content of the oats has fallen well below 12 per cent, so that the oats when cooled still show some 20–60 per cent of their original lipase activity. In the manufacture of oatflakes, the dehulled oats or groats are given a further steam treatment which usually eliminates all lipase activity. Oatmeal, however, which does not receive this steam treatment, is frequently the subject of complaint because of the hydrolysis of its own fat during storage or that of the other fatty ingredients when it is used in biscuits, oatcakes, etc.

Adequate steaming of oats is one method of destroying the lipase, and some oatmeal millers now include this treatment even in the manufacture of oatmeal. It is, however, not the perfect solution, because there is another form of fat spoilage in oat products—oxidative rancidity—and there is the possibility that in destroying lipase by heat this second type of rancidity may be encouraged. The danger is small in the normal distribution and sale of oatmeal, and is seldom encountered except in meal or flakes stored for abnormally long periods. Nevertheless, it is desirable to explore other possible methods of inactivating lipase, and in attempting this it is useful, if not necessary, to know where the enzyme is located within the oat.

Earlier work suggested that the esterases of grain are present either within the aleurone layer or in the outermost portion of the endosperm rather than in the embryo or scutellum portions of the germ. In the case of oats, this is in keeping with the fact that the lipase activity of the germ-half of the kernel is slightly less than that of the distal half. However, removal of the outer pericarp of otherwise untreated groats by careful scraping down to the testa reduces their lipase activity by about 98 per cent; at the same time, the scrapings have a very high activity. Much of the small residual lipase activity in the abraded grain is associated with the inaccessible portion of the pericarp and vascular bundle inside the crease. Thus the bulk of the active lipase in oats lies within the pericarp, that is, above the testa and not in the aleurone layer.

Dry scraping is an extremely tedious operation, but, if the groats are immersed in water for about two minutes, the adhesion between the pericarp and the underlying testa is so reduced as to permit the former and its contained lipase to be easily brushed off. Alternatively, if intact groats are immersed in acid at pH 1 at ordinary temperatures, about 96 per cent of the lipase is destroyed within thirty minutes. These groats are still capable of germination, and we have grown them on sand to a height of 15 cm. without observing any differences from the behaviour on germination of normal untreated groats. Similarly, groats with their pericarps removed by gentle wet brushing also germinate normally; furthermore, after seven days germination, their lipase activity—particularly marked in the shoots—exceeds that of the original unscraped groats. Apparently, therefore, lipase previously 'bound' is released or lipase is synthesized during germination.

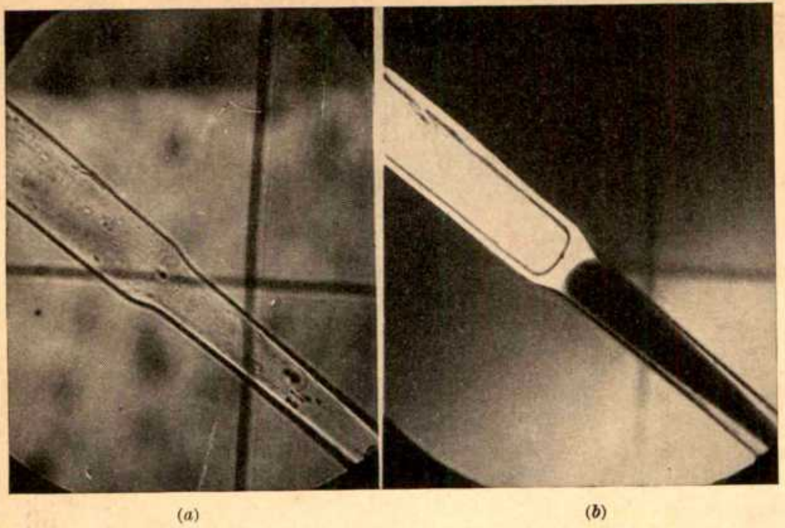
The several aspects of this work will be published in detail elsewhere. It has been carried out as part of a programme of research for the oatmeal millers of England and Scotland.

PHYSICAL STUDIES OF NUCLEIC ACID

Nucleic Acid: an Extensible Molecule ?

THE negative birefringence and ultra-violet dichroism of streaming solutions and fibres of sodium thymonucleate[1-3] has been taken as indicating a long molecule with purine and pyrimidine rings roughly at right-angles to the length. Astbury[4] has observed by X-ray diffraction a 3·4-A. spacing along the length of the fibres, and has suggested that the nucleotides are flat and lie 3·4 A. apart. We have studied in more detail the properties of sodium thymonucleate fibres and have confirmed the above general conception, but have observed an unusual stretching phenomenon in the fibres which suggests that the long molecules may be extended into a second form.

The main experimental facts may be summarized as follows. Fibres in air of 50 per cent humidity are partly crystalline with remarkably well-oriented crystallites. Birefringence, ultra-violet dichroism[3] and most of the infra-red dichroism[5] are all negative. The fibres have little elasticity, and, when a fibre of uniform diameter is stretched beyond the yield point, necks of approximately zero birefringence appear in the negative fibre. These necks have a uniform diameter about 20 per cent less than that of the negatively birefringent part of the fibre (see photograph). On further stretching, the shoulders at the ends of the necks move apart along the fibre. In addition to the increase in length of the necks due to



Fibres of sodium thymonucleate. × 1,000

(*a*) Shoulder at end of neck; (*b*) same between crossed nicols, with compensation, showing thicker portion of fibre negatively birefringent and the thinner portion or neck positively birefringent

this process, the necks also lengthen by stretching and become positively birefringent (0·02). Such material is non-crystalline, non-dichroic in the ultra-violet, and most of the infra-red dichroism is positive. The fibre is roughly double its original length when the breaking point is reached. The positively birefringent fibre is stable at 50 per cent humidity but returns to the negative form, with complete disappearance of necks, when placed in a humid atmosphere, the length shrinking from about 1·5 to 1. Probably the reversible part of the stretching is in roughly this ratio, and some irreversible stretching occurs after the phase change of the necking has taken place. Similar phase changes may be produced by rolling or stretching sheets of thymonucleate and fibres of thymus nucleoprotein.

The fibres swell and shrink markedly when the humidity of the surrounding air is varied. In saturated water vapour the fibres are largely microcrystalline; but, on reducing the humidity to 50 per cent, a reversible change takes place, the greater part of the crystallinity disappears, length is reduced by approximately 30 per cent, cross-section is halved, and the birefringence per unit mass of nucleic acid and the ultra-violet dichroism are reduced. More complete dehydration is obtained by warming in air or *in vacuo*, when approximately 10 per cent shrinkage in diameter and length takes place, all crystallinity disappears, the infra-red dichroism is reduced, and the negative birefringence drops to 0·02, which is less than half that at 50 per cent humidity. The dried fibres are rapidly hydrated only if placed in an atmosphere of more than 50 per cent humidity.

There is little change in X-ray spacing along the length of the fibre on drying, and, in view of the great length of the molecules, which is probably at least 1000 A., it would appear likely that most of the increase of length of the fibre on hydration is associated with the change from the amorphous to the crystalline state, and is not due to water packing between crystallites. Presumably, on dehydration, the backbone of phosphate ester linkages in the molecule becomes crumpled and the purine and pyrimidine rings tilted; and, on hydration, the molecules pack regularly together and become extended in length with the purine and pyrimidine rings approximately at right-angles to the length. It is also unlikely that the reversible extension of the fibre on stretching is due to reversible slipping of molecules over one another, and it is difficult to avoid the conclusion that these molecules have been extended in length during the necking process. The optical observations show that the purine and pyrimidine rings have rotated during this process and lie on the average at about 45° to the length of the fibre.

When one considers the general form of the nucleic acid structure, a hypothesis which could explain these observations comes to mind. Nucleic acid consists broadly of large flat rings closely packed together[4,6], each nucleotide being joined to the next by a single chain of bonds. Such a system might be deformed very easily, and the rings might slide over one another from one equilibrium position to another (corresponding to the discontinuous process of necking) while keeping their separation roughly constant. If the general direction of the phosphate backbone of the molecule is kept straight during this process, extension of the backbone-length in the ratio of 1 to $\sqrt{2}$ would mean tilting the rings from 90° to 45° as observed. The extension could take place by rotations of the bonds in the backbone-chain relative to one another, the bond-angles being kept roughly constant.

Whatever the precise mechanism of the necking process, its study may well cast light on the structure of nucleic acid. So far the X-ray diffraction picture of the positive phase shows only diffuse rings, but in the case of infra-red dichroism the change of orientation of the units in the molecule gives much extra information[5].

We wish to thank Prof. R. Signer for sodium thymonucleate, Dr. K. A. Smith for nucleoprotein, and Prof. J. T. Randall and Dr. R. E. Franklin and colleagues for discussion. A fuller account of this work will be published later. We are indebted to the Chemistry Department of King's College for the use of its X-ray equipment.

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Evidence on the Structure of Deoxyribonucleic Acid from Measurements with Polarized Infra-Red Radiation

THIS communication is a preliminary account of a study of the nucleic acids by means of infra-red radiation; we shall discuss the extent to which our measurements support existing models of these polynucleotide structures.

On the basis of X-ray diffraction patterns from oriented sodium deoxyribonucleate fibres, Astbury[1-3] has proposed a model in which the nucleotides, which he supposed to be nearly planar, are piled directly on each other in stiff columns, with their planes roughly perpendicular to the axis of the molecule. Meridian arcs corresponding to axial repeat distances of 3.34 and 27 A. were observed in the X-ray diffraction patterns, and presumed to correspond to the separation of nucleotides, and a repeat of pattern every eight or sixteen nucleotides. The larger repeat was associated with the tetranucleotide constitution favoured at that time.

Since these ideas were put forward, little experimental support has been found for the tetranucleotide hypothesis, and recent X-ray studies of the ribose nucleosides by Furberg[4] have shown that in the crystal these nucleosides are not planar. The planes of the D-ribose and pyrimidine residues were found to be nearly normal. Furberg[5] supposes that this configuration is present in deoxyribose nucleic acid, and has proposed two modifications of Astbury's structure. In one case the backbone of sugar rings and phosphate groups forms a spiral enclosing the bases; in the other the backbone is a zigzag chain with the bases outermost. The infra-red dichroisms which we have observed in oriented films of sodium deoxyribonucleate can be interpreted in terms of a structure similar to that proposed by Furberg.

A detailed discussion of the chemical methods employed in preparing the material, and the assignment of the infra-red absorptions, will be given in a later publication, but the main features will be summarized here. The material was obtained from calf thymus by a modified form of the techniques used by Mirsky and Pollister[6], and Signer and Schwander[7]. Minced thymus gland was washed with citrate buffer (*p*H 6.8) containing a trace of thymol, and extracted with 0.14 *M* sodium chloride. The residue was extracted with 1 *M* sodium chloride, and the resulting nucleoprotein solution deproteinized by the Sevag[8] technique. The sodium chloride was removed by dialysing against distilled water, and the sodium deoxyribonucleate stored in the frozen-dried state until required.

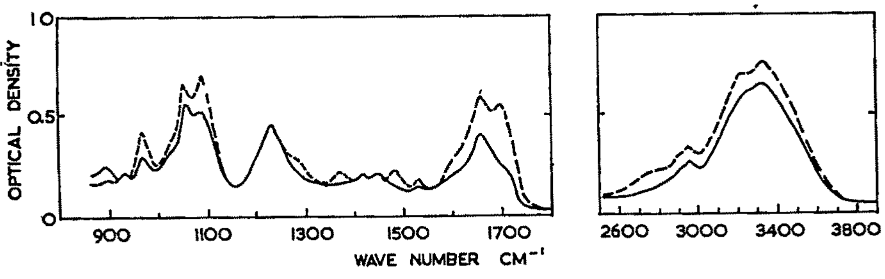
Oriented samples were obtained by shearing viscous solutions on a microscope slide treated so as to have a non-polar surface. The films obtained by this method were extremely thin, and negatively birefringent with respect to the direction of shear. The infra-red measurements were made with a reflecting microscope, of numerical aperture 0.8, used in conjunction with a Grubb-Parsons infra-red spectrometer[9]. By this method small areas *c*. 0.5 mm × 0.05 mm. were selected in which the film was of uniform thickness and showed high orientation.

The spectra obtained are indicated in the diagram, in which the optical density is plotted against wave-number with the electric vector vibrating parallel, and perpendicular, to the direction of shear. The main features of the spectra are the regions of intense absorption around 3,300, 1,700 and 1,050 cm.$^{-1}$, all of which show a greater optical density with the electric vector vibrating perpendicular to the direction of shear (perpendicular dichroism).

The bands at 3,335 and 3,210 cm.$^{-1}$ are most probably N—H stretching vibrations of the amino- and imino-groups of the purine and pyrimidine residues, whereas the bands at 1,660 and 1,700 cm.$^{-1}$ are double-bond (C = O, C = N, C = C) vibrations of these ring systems. In both cases the transition moments associated with the vibrations will be in the plane of the ring. The perpendicular dichroism of these vibrations supports the approximate perpendicularity of the planar bases to the chain-axis. Further confirmation of this is obtained from the ultra-violet dichroism[10-12], and the fact that the optical birefringence is negative. The high water content of these films probably accounts for the different dichroic ratios of these bands, since water absorbs intensely near 3,450 and 1,640 cm.$^{-1}$

The strong band at 1,087 cm.$^{-1}$ is believed to correspond to a C_1—O—C_4 vibration in the sugar residue, and the 1,052 cm.$^{-1}$ band to a C—O—P vibration[13]. The transition moment associated with the C_1—O—C_4 vibration is likely to be in the C_1—C_4 direction, so that the perpendicular dichroism observed is consistent with Furberg's model. Two P—O—C vibrations are to be expected, one corresponding to the nucleoside-phosphate ester linkage (P—O—C_3), the other to the internucleotide ester linkage (P—O—C_5). The relative intensities and directions of transition moment are not known; but if it is assumed that the intensities are equal, and the transition moments are in the direction P—C_5 and P—C_3, the observed dichroism is of the correct character.

The valence vibration of the phosphoryl (P = O) group is known to occur around 1,250 cm.$^{-1}$ [13,14], and it seems likely that the main component of the band observed at 1,235 cm.$^{-1}$ is associated with this vibration. By analogy with the carbonyl group, lower frequencies are expected where hydrogen bonding occurs. The absence of dichroism indicates an effective transition moment inclined at 54½° to the chain-axis. The Furberg model requires a perpendicular dichroism for this vibration, but a consistent modification is obtained by a slight reorientation of the phosphate group. Alternatively, the partially resolved perpendicular



Infra-red spectrum of sodium deoxyribonucleate, obtained with polarized radiation. The full curve corresponds to the electric vector vibrating parallel to, and the broken curve perpendicular to, the direction of shear band at *c* 1,290 cm^{-1} could be assigned to this vibration, though this seems less probable

Recent observations by Wilkins *et al* [15] suggest that a reversible change occurs in the structure of oriented films and fibres when they are stretched or rolled These observations are supported by infra-red measurements, which show that the dichroisms of the 3,335, 3,210, 1,700, 1,660, 1,087, 1,052 and 967 cm^{-1} bands are all reversed to parallel, whereas the dichroism of the 1,235 cm^{-1} band remains unchanged at a value of unity

The results obtained so far do not contradict the original Astbury model, but we have preferred to interpret our results in terms of Furberg's modification, in view of his recent evidence on the stereochemistry of ribose nucleosides, and the steric distortions of the phosphate oxygens required in Astbury's model[2] The assignment of the perpendicular band at 967 cm^{-1}, which shows a marked reversal of dichroism on stretching, may throw new light on this question

We wish to thank Prof J T Randall for his continued advice and encouragement in this investigation, and Drs M H F Wilkins and W C Price for helpful discussions One of us (R D B F) wishes to acknowledge a Medical Research Council Studentship

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Feb 29

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EDUCATION AND PHYSICS

ANNUAL CONFERENCE OF THE EDUCATION GROUP OF THE INSTITUTE OF PHYSICS

THE second annual conference of the Education Group of the Institute of Physics was held during April 5–7 at the Institute's house at 47 Belgrave Square, London, S W 1, with W Somerville Vernon (City of Cardiff Technical College) as chairman In opening the conference, Prof W E Curtis (president of the Institute) said that the membership of the Group is now about 250 The Institute has a wider interest in educational matters than a mere concern with the teaching of physics, and it welcomes teachers as members , Prof Curtis recalled that teaching experience at an adequate level is now recognized by the Institute as fulfilling one of the conditions for corporate membership

Prof F A Vick (vice-principal, University College of North Staffordshire), speaking on "An Experiment in University Education", described the curriculum which has been worked out at the University College of North Staffordshire for a residential course of four years duration, leading to the honours B A degree This is planned to give a more general education than the conventional university courses, and to break down the narrowness of specialization. Students are not required to select their special subjects for honours until the second year, the first year being spent on a carefully planned common course which is compulsory for everyone and intended to broaden the outlook and also arouse interest in possible specialist subjects which may not have been dealt with at school Intending teachers take an education course extending over the whole of their last three years, which counts as one of the subsidiary subjects required for their degree

The need for a broad general outlook in industrial research was one of the points mentioned by Dr R S Silver (director of research, Federated Foundries, Ltd , Glasgow) in a paper on "Industrial Metaphysics" There are, he said, many matters beyond the accepted scope of physics with which an appropriate extension of the physicist's education might help him to deal The man engaged in industrial research cannot dispense with an advanced academic training, for he needs to appreciate that scientific work is more than a mere application of logic and that theory is not simply a question of mathematics Sometimes, fruitful results may come from obviously wrong assumptions, which raises the question as to the meaning of 'truth' in research of this kind , an idea which works can be taken as true for this purpose But the worker must have had a training in rigid physical procedure, up to good honours degree level, before he can hope to know when it is permissible to take liberties. This specialist training should be broadened and fortified by more general studies, to encourage the attitude of mind which is prepared to explore several points of view and, when necessary, challenge accepted ideas

Discussion centred around the theme linking both these papers, namely, the general education appropriate to the specialist Dr R Furth (Birkbeck College London) believed that this should come at as early a stage as possible, and spoke of the introductory first year at Birkbeck , Prof A D. Ross (University of Western Australia) said that the idea of the common first-year course has been discussed in Australia, but one of the main considerations hindering its adoption has been the difficulty of students dropping for a year a proposed special subject in which they may have specialized to a high level at school Looking back on the discussion, one began to realize that the new General Certificate of Education may well provide in the schools just that preparation required for first-year university work as outlined by Prof Vick

At the evening session, J Tienaman (assistant further education officer, British Broadcasting Corporation) spoke on "Attempts to Assess the Understanding of Broadcasts on Science" He said that the rules for preparing an intelligible script are well known , but care in this matter is not the most important factor Experiments with listeners in the Armed Services have shown that the chief contribution to the understanding of a broadcast is an interest in the subject-matter, however involved the actual presentation might be Mr Trenaman gave examples of studies of the comprehension and retention of scientific matter presented in different ways, from a first-hand account of modern work by a distinguished man of science to a dramatized scene built around one simple fact The former proved intelligible to a greater or less extent to only some ten per cent of the listeners, while sixty per cent retained some knowledge of the latter Attempts to correlate interest and understanding appear to show that interest increases with understanding up to a point, but it seems that the most enthusiastic listeners often understand the material relatively imperfectly This result is perhaps not surprising when it is considered that an essential condition for learning by adults is that interest shall provide a stimulus by ranging ahead of understanding and creating a desire to master the material

The morning session on April 6 dealt with the topic of M K S units G R Noakes (Uppingham School) gave a brief history of the movement towards the adoption of the M K S system in electrical teaching, and said that the real point which may dispose school teachers towards its use is the opportunity that it offers for approaching the subject of electromagnetism at an elementary level in a new and perhaps more attractive way This new approach was described in detail by Dr J Goodier (Lancing College), who spoke of his experience in developing a school course in electricity and magnetism based on the rationalized M K S system He said that, while the real starting point is the choice of the ampere, as defined by the International Electrotechnical Commission, for a fourth fundamental unit it might be well to compromise at the earliest stage by starting with the coulomb as defined electrolytically Having measured magnetic flux density in volt-seconds, and defined magnetic field-strength in amperes per metre, direct measurement of the permeability of space, or rather the ratio of B to H for an air-cored solenoid, can be carried out Similarly, direct measurement of the capacitance of a parallel-plate air condenser gives the permittivity of space to a reasonable degree of accuracy, so that the figures appearing in formulæ are those of measurements and not arbitrarily chosen values At a more advanced stage, the derivation of practical standards in terms of the ampere, using a current balance, can be explained, and Dr Goodier showed a simplified current balance made for this purpose He concluded with a warning against giving the student the impression that the form of a physical expression depends in any way on the system of units chosen, and pleaded for care in writing down formulæ in such a way that they are dimensionally correct

A number of interesting questions arose for discussion—as to whether much would be lost by abandoning the historical approach via magnetism, whether experiments in magnetostatics are themselves worth retaining for the experimental skill they might develop, and whether there is an optimum stage in the student's career at which the question of units might profitably be explained fully Mr F A Meier (Institute of Education, University of London) welcomed the new approach with enthusiasm, and regretted that it had not arisen during his own teaching days Other speakers mentioned the difficulties of changing teaching methods already established, and the problem that may arise when students have to be prepared in the same class for a number of different external examinations

An evening lecture, open to the public, was given in the Fyvie Hall of the Polytechnic, Regent Street, London, W 1, by Prof A M Tyndall (emeritus professor of physics, University of Bristol), with the title "Atomic Particles—a Survey of Recent Discoveries" Prof Tyndall described the work of Prof C F Powell's team at Bristol, using the photographic plate technique, and gave an account of the discoveries made by this method He described, and indeed conveyed in no small measure, to the audience the atmosphere of enthusiasm in which the work is carried on, and the delight with which he had watched the results appearing This most inspiring lecture, forming as it did a kind of centre-piece to the conference, was received with great appreciation

The final session, on the morning of April 7, was spent in considering the teaching of the history of science, a matter which had been referred to in many of the previous papers Dr F Sherwood Taylor (director of the Science Museum, London) spoke on "Some Difficulties in the Historical Method of Teaching Science, as exemplified by the History of the Thermometer" Quoting Dr Charles Singer, Dr Taylor said that the history of science itself is indeed a difficult study, probably more appropriate at postgraduate level than at school A further difficulty confronts the teacher, since students are on the whole anxious to learn how things work and to apply this knowledge, rather than to think very much about origins Again, it is difficult for anyone at the present day to understand the ways of thought of our ancestors without a deep acquaintance with their ways of life Broader syllabuses are desirable, but it might be well for the historical aspects of science to be taught by a historian with a scientific background Dr Taylor then examined in detail the legend crediting Galileo with making the first thermometer, and showed that, while several devices similar to that of Galileo were made at various earlier dates, there was much uncertainty as to what they were meant to do, and why they did it It seems, then, that by going beneath the surface of the legend and aiming at historical accuracy, one reaches a position at which the purely scientific interest is reduced, though valuable work can be done in emphasizing the difficulties that faced the pioneers In the discussion, many teachers spoke of their own experiences in dealing with the historical aspects, and the difficulties encountered Several people of mature experience admitted that it was only relatively late in their own teaching careers that they had been attracted by the historical development of their subject

S R Humby (Winchester College) read a paper asking "Will School Studies of the History of Science produce a Scientific Outlook?" He said that time allowance and the limitation of the pupils' previous scientific background both suggest that the best way of treating the history of science is by the anecdotal method It might be possible to deal with the development of individual topics in the last year of a Grammar School course, when the pupil's own laboratory experience has fitted him to appreciate some of the problems of the scientific worker General discussion classes, aimed at encouraging a scientific outlook, would draw largely for their material from historical sources Mr Humby believed that such discussions might, indeed, achieve their aims, if they are preceded by experimental work and conducted by a teacher who is himself alive to their importance Mr Meier said that one of the lessons to be learned from the past is that the ideas as well as the methods of science are continually changing, and that science is a living and growing subject Prof Ross mentioned that it might be well that our pupils should learn of the distinguished parts played by British men of science in exploring new fields, and also advocated bringing in historical matter at all stages of the course, he said that he is against anything that savoured of dividing up the subject into water-tight compartments He agreed that the formal study of the history of science at postgraduate level would be of great value to the intending teacher himself G R NOAKES

FOREST GENETICS

FOREST genetics research is of comparatively recent origin in Great Britain, and the presence of two distinguished Continental workers at the British Association meeting at Birmingham did much to stimulate a lively interest in a meeting of Section K* to discuss this subject Dr Syrach Larsen, director of the Horsholm Arboretum, Denmark, who is the pioneer European worker, described his method of tree breeding in general terms Dr Bertil Lindquist, director of the Botanical Gardens, Gothenburg, Sweden, dealt with the improvement of birch in Sweden, and a short description of the work in progress in Great Britain was given by J D Matthews

The object of tree breeding research is to provide the forester with seed capable of producing the highest yielding crop of well-formed and healthy timber trees on the sites which are available Both the guest speakers paid considerable attention to their improvement work based upon the variation found in Nature, and Dr Syrach Larsen's description of his method of breeding based upon vegetative propagation is worthy of some discussion here

The process commences with the selection of a number of individuals possessing outstanding vigour and form of growth These are brought together into one central place by means of vegetative propagation (grafting, budding, and the rooting of cuttings) The genotype is determined in 'tree displays' in which several clones are planted in widely spaced lines As the clones develop, the inherent shape and vigour of the selected trees become evident, and observations on date of flushing, flowering and leaf-fall, resistance to insect attack and disease can be made The breeding qualities of the selected trees are next determined by means of controlled self- and cross-pollinations also made in the tree displays, and individuals of high combining ability may become evident at this stage The subsequent progeny trials are followed for five years in great detail, and must be kept for reference for at least twenty years Finally, special seed orchards are formed from those individuals which possess the desired characteristics

These seed orchards are managed along the same lines as the modern fruit orchard, and selected root-stocks are used for establishing clones of the tested (élite) individuals in areas where the species under study is absent or rare, thus reducing the incidence of foreign pollination from trees of the same species There is also the ripening of the seed to be considered, and specially favourable areas for seed production are selected as sites for these seed orchards

Dr Larsen pointed out that although the improvement of forest trees is apparently hampered by the slow succession of generations, in fact the long life-span of the parent tree has proved to be a great advantage A good breeding parent can be preserved as a seed producer for at least seventy years, and every improvement gained is available for a considerable period as a stepping stone for further work Tree breeding also differs from agricultural breeding in that genetic uniformity is not so important in a tree crop as in an agricultural crop More than ninety per cent of the population must be removed in thinnings during the development of the stand, and this gives opportunities for a continuous selection of improvement during the life of the crop

Dr Lindquist has worked for some years in Sweden in collaboration with Mr Holger Jensen, a private owner He described a seed orchard of *Betula verrucosa* sited in southern Sweden which contains ninety grafts each of nine élite trees spaced at approximately twelve feet apart The first crops of seed have been obtained The selection of the parent trees was based upon the study of the variation in the Scandinavian *Betula verrucosa* Ehrh, and Dr Lindquist's account of this work proved of interest to the meeting as an example of the methods used by tree breeders

Two main varieties of *Betula verrucosa* are recognized by Dr Lindquist, the variety *saxatilis* Lindq, which is found throughout Central Europe and in the central and southern U S S R, and the variety *lapponica* Lindq, which occurs in northern Europe Timber quality within the latter variety has been correlated to some extent with the external appearance of the bark Trees with smooth white bark generally yield a smooth mild timber with straight elastic fibres—a combination found suitable in the turnery industry Individuals are found in southern Sweden which possess a rough, heavily fissured bark with hard timber and fibres not so straight or so elastic This type of wood is used for furniture Other types have been differentiated on the basis of figured grain, and these include the curly birch, the flamy birch, the ice birch and the brown curly birch, all identifiable by bark characteristics Within these groups the individuals selected for inclusion in the seed orchards must have made very strong growth throughout their lives and must possess good form of growth A number are chosen from within a specified provenance zone, there being a separate seed orchard for each zone

The progress of work in Great Britain was described towards the end of the meeting and emphasis was laid upon the importance of the survey, now in progress, of the potential seed-producing population of the species chosen for study The species being studied in Great Britain are beech, oak and ash, Scots pine, Corsican pine, Sitka spruce and the larches, and a number of seed sources have been located for each of these species The selection of individuals from which seed orchards are to be formed is being made concurrently with the above survey, and some examples of the type of trees being selected were displayed to the audience

In the discussion which followed the three papers it was emphasized that, if speedy progress towards the improved growing stock desired is to be made in Great Britain, the idea of the value of genetics in day-to-day forest practice must be repeatedly emphasized It is perhaps one of Dr Larsen's greatest achievements that he has obtained the goodwill of practising foresters in Denmark, who are now firmly convinced of the importance of the inherent qualities of trees, and who will take great trouble in the selection of seed parents for their future forest crops. Much can be done in a similar manner in Britain J D MATTHEWS

THE 800-kV. NEUTRON GENERATOR OF THE UNIVERSITY OF ISTANBUL

By Prof. FAHIR E. YENIÇAY

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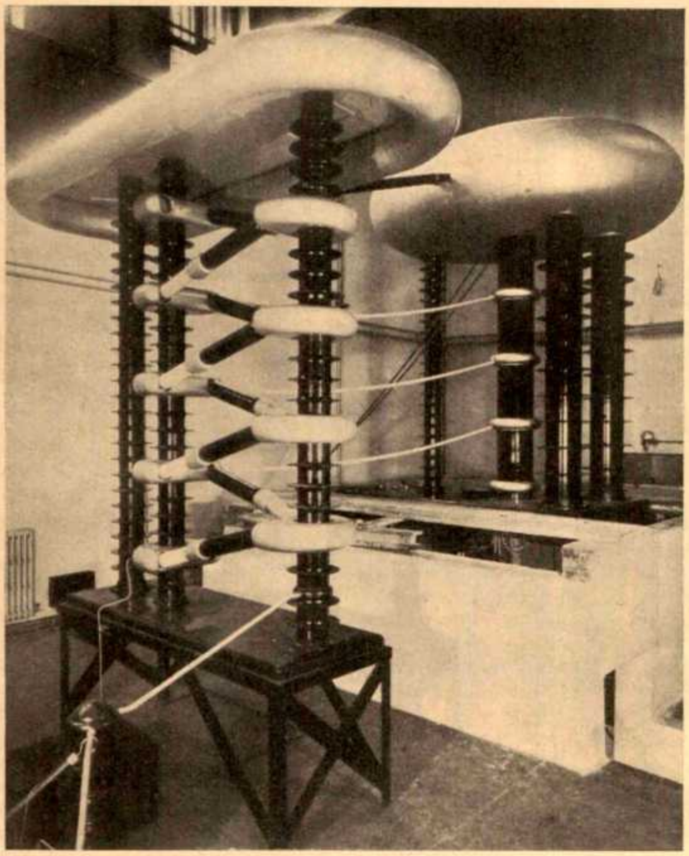
FOR nuclear research purposes, a Philips neutron generator of 800/650 kV. was installed in October last in the General Physics Department of the University of Istanbul. The high-tension equipment had been delivered in May 1949; a general view of the installation is given in the accompanying illustration. The platform on which the acceleration tube, the oil-immersed measuring resistance (1,684 MΩ) and the two columns supporting the top stand is carried on steel girders resting on concrete walls, and the working room is to be seen under the platform.

The high-tension generator presents some last improvements[1]. The valves are heated by the interposition of small transformers fed by high-frequency current (250 kc./sec.). The oscillator is of the type *TB.*2·5/300 with variable condenser and variable grid resistance. The small autotransformers have cores of 'Ferroxcube', consisting of two *E*-shaped massive pieces. The current in the secondary is 3·5 amp. The small differences between the average current and the heating current of the valves are regulated by changing the connexions on the primary winding. The apparatus provides target currents of ~ 170 μamp. (protons or deuterons) at a voltage of 650 kV.



In order to have an idea of the neutron (Be + D) intensity, we compared the activity of a narrow silver ribbon (0·05 mm. thick) irradiated by the slow neutrons (paraffin) of the apparatus (600 kV.; ~ 130 μamp.) and the activity of the same silver ribbon irradiated under the same conditions with the neutrons of a radium–beryllium source (80 mC.). We find that the (Be + D) source is equivalent roughly to 5 gm. of (Ra + Be).

I should like to express my thanks to Messrs. Philips for their care and for material generosity during the installation.

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SKULL OF THE FŒTAL NARWHAL

A RECENTLY published account, by Dr. Nellie B. Eales, of two fœtal narwhal skulls* should appeal alike to the embryologist and general student of the Cetacea. A detailed description is given of the chondrocranium, osteocranium and teeth of a smaller (137 mm.) specimen, supplemented by a briefer survey of the skull of a larger (150 mm.) specimen. Although little different in size, the larger specimen showed considerable advance in development compared with the smaller, evinced by an elongation of the skull, a dorsal movement of the blow-hole position, doming of the cranium and a spreading of the membrane bones.

Figures of wax-plate reconstructions of the membranous labyrinth bring out most clearly the enormous relative size of the cochlea and, by implication, its importance to animals the environmental impressions of which must for the most part be auditory.

The discovery of hair germs in the fœtus of a species so long and often quoted as lacking this feature is noteworthy; so also is the fact that, including the tusk on the left side (which in the male may grow to a length of some eight feet) and its reduced fellow in the right maxilla, the fœtus shows evidence of the presence of six teeth on each side of the upper jaw and two on each side of the lower jaw.

In her comparison of the narwhal fœtuses with those of other cetaceans and with other orders of mammals, the author is careful not to come to premature conclusions about affinities on the limited material so far available, but uses her findings in the inter-parietal region to question the view of Slepzov that reptilian features persist in the developing odontocete skull. Very recent and independently pursued serological and histological researches suggest that the affinities of the Cetacea are rather with the Artiodactyla and to this extent justify Dr. Eales's objection to Slepzov's theory.

F. C. Fraser

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* The Skull of the Fœtal Narwhal, *Monodon monoceros* L. By Dr. Nellie B. Eales. *Phil. Trans. Roy. Soc.*, B, **235**, No. 621, pp. 1–33.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Internal Rotation of Methyl Groups in Cadmium Dimethyl

In view of current interest in the problem of free or restricted internal rotation in molecules, we may mention briefly some results which indicate free rotation of methyl groups about the Cd—C bond in cadmium dimethyl. We have already described[1] measurements on the rotational fine structure of some vibrational bands of zinc dimethyl and mercury dimethyl, which provided strong evidence for such free internal rotation in these molecules. The infra-red absorption spectrum of cadmium dimethyl has now been measured with greater resolving power than that previously used by Gutowsky[2], particularly in the region of 3 μ.

Our results agree substantially with those of Gutowsky, although we have not observed some weak bands found by him, and the contour of some bands suggests a different frequency assignment. There is a parallel-type band at 2,925 cm.$^{-1}$ with spacing of P—R branch maxima close to 17 cm.$^{-1}$, which agrees with that to be expected from the rough value of the moments of inertia. The most important feature is a perpendicular-type band centred around 2,980 cm.$^{-1}$ with clearly separated Q branches, roughly 10 cm.$^{-1}$ apart, each third line being stronger than its neighbours. As pointed out in the earlier paper, the separation of Q branches in the same species of band with ethane is about 5 cm.$^{-1}$, and the greater separation found here, which agrees with that reported for zinc dimethyl and mercury dimethyl, cannot be explained satisfactorily by Coriolis interaction. It falls into line exactly with the spacing expected if there is free internal rotation.

Full details of this band and the whole spectrum will be described later elsewhere.

D. R. J. Boyd
R. L. Williams
H. W. Thompson

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Oxford.
Jan. 26.

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[1] *Trans. Farad. Soc.*, Cambridge Discussion, 1950.

[2] *J. Amer. Chem. Soc.*, **71**, 3194 (1949).

Evaporation and Mobility of Naphthalene Molecules

In a recent communication[1] under this title, V. J. Clancey has given a short account of a beautiful experiment on this subject. Among his very interesting results he gives a provisional value for the mean displacement x_s of adsorbed molecules of the order of a few millimetres. Having been connected with these problems, during the development of a theory of crystal growth from the vapour, in collaboration with W. K. Burton and F. C. Frank[2], his value seems to me too high for ordinary temperatures. The purpose of the present communication is to show that much smaller values of x_s can be deduced indirectly from Dr. Clancey's results.

The experimental arrangement is as follows. A spot of solid naphthalene was placed on a surface (mica, glass, etc.) and covered by a thin glass hemisphere, leaving a small aperture between the two. Adsorbed molecules will then escape from the hemisphere and travel for an average distance x_s prior to evaporation into the vacuum. Two such assemblies were mounted, facing opposite directions, at the sides of an axis of suspension, to produce a torque when evaporation took place.

The concentration N of adsorbed molecules outside the hemisphere must satisfy the equation

$$x_s^2 \nabla^2 N = N, \qquad (1)$$

where x_s, the mean displacement, is given by

$$x_s^2 = D_s \tau_s, \qquad (2)$$

D_s being the diffusion coefficient and τ_s the mean life of the adsorbed molecules. The boundary conditions at the edge of the hemisphere become $N = N_0$ if the edge is open and $N = 0$ otherwise. We suppose the aperture to cover an angle 2θ on the side opposite to that facing the axis of suspension. The torque T produced by the corresponding distribution N is readily calculated, and the result is

$$T = T_0 \{(K_1/K_0)\,\theta + (\rho/X)\,(K_2/K_1) \sin \theta\}, \qquad (3)$$

$$T_0 = \alpha\,(2\pi mkT)^{1/2}\,\tau_s^{-1}\,N_0 x_s \rho X. \qquad (4)$$

In these expressions K_1 are Bessel functions going exponentially to zero for $r \to \infty$; the argument is always ρ/x_s, where ρ is the radius of the hemisphere. X is the distance from the centre of the hemisphere to the axis of suspension. The factor α in (4) is a complicated one, depending on the actual law of interaction and the mechanism of energy transfer between the surface and the adsorbed molecules[3]; in simple cases it should not be very different from unity.

We think it a good approximation to suppose $\rho/x_s \gg 1$ (otherwise the calculations would have to be more complicated); then (3) becomes, neglecting $(x_s/\rho)^2$,

$$T = T_0 \{\theta + (\rho/X) \sin \theta + \tfrac{1}{2}\,(x_s/\rho)\,[\theta + 3\,(\rho/X) \sin \theta]\}. \qquad (5)$$

It is therefore clear that a value of x_s could be deduced, at least in principle, from the variation of T/T_0 as a function of θ, as it was originally intended by Dr. Clancey. Unfortunately, x_s/ρ is so small, in our opinion, that the second term in (5) cannot be used for this purpose.

Nevertheless, it seems to me possible to deduce interesting information from the absolute value (4) of T_0. Let us assume that the adsorption energy is small and the temperature not too low, so that the concentration N_0 of adsorbed molecules inside the hemisphere is small. Then this concentration, in equilibrium with the vapour pressure p of naphthalene, will be given by $N_0 = p\tau_s(2\pi mkT)^{-1/2}$, and (4) will become

$$T_0 = \alpha(\rho X)(p x_s), \qquad (6)$$

where all the factors are known except x_s (if we accept $\alpha \sim 1$).

When the surface can be considered as a more or less perfect crystal surface, we can write for x_s

$$x_s \sim a \exp\{\tfrac{1}{2}\,(A - U)/kT\}, \qquad (7)$$

where A is the adsorption energy and U the activation energy necessary for the displacement of an adsorbed molecule from an equilibrium position to the next, distant a from each other. Then the exponential factor in (6) will be exp $(-E/kT)$ with

$$E = W - \tfrac{1}{2}(A - U), \qquad (8)$$

where W is the evaporation energy for naphthalene. From the known value $W = 18.2$ k cal [4], and those obtained by Clancey for E, one obtains values for $(A - U)/2$ going from 5 to 2 k cal, which are of the order one would expect. The corresponding values of x_s at room temperature, from (7), range from 10^{-4} to 10^{-6} cm, again as we should expect. It should also be noticed that the factor outside the exponential in (6) will be essentially determined by that corresponding to p, and therefore will be practically independent of the substrate, as is observed by Clancey.

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Nov 30

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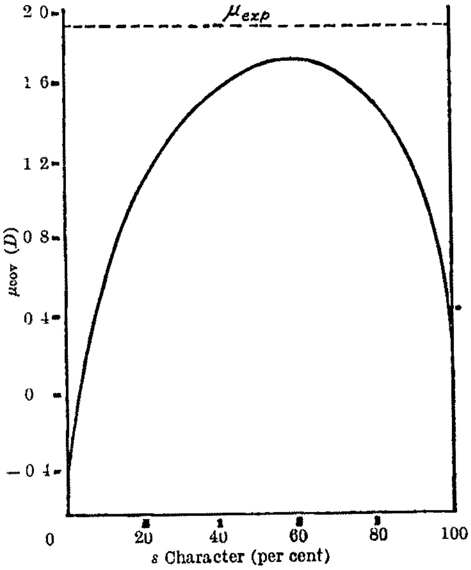
Dipole Moment and Ionic Character

One well-known application of the concept of ionic-covalent resonance is in the field of dipole moments, where it has been used, in a simple way, to correlate the observed dipole moments of bonds with differences in electronegativity[1]. However, recent work, notably that of Mulliken[2], Coulson[3], and Robinson[4], has cast doubt upon the validity of some of the assumptions made in this treatment[5]. One of these assumptions is that the dipole moment of a pure covalent bond is approximately zero.

Robinson[4] has calculated the dipole moment, μ_{cov}, of a pure covalent HCl bond using a Heitler–London type of wave function. He obtained a value of $-0.98\,D$, that is, the hydrogen atom negative, whereas the experimental value is $+1.10\,D$[6]. He found that the calculated value of μ_{cov} was extremely sensitive to sp hybridization of the chlorine orbital. A value of $\mu_{cov} = +1.10\,D$ is obtained with about 10 per cent s character. Robinson, therefore, points out that the observed dipole moment can be accounted for without invoking contributions by ionic structures, and concludes that "Dipole moments do not give a good method for determining the ionic character of bonds".



We have carried out the same type of calculation for hydrogen fluoride, using Robinson's equations[4] and evaluating the appropriate integrals. Using a $2p$ fluorine orbital (unhybridized), the following values for the dipole moment of a pure covalent HF bond were obtained: (*a*) $\mu_{cov} = -0.40\,D$, with hydrogen-like functions and an effective nuclear charge of 4.84 for fluorine[7], and (*b*) $\mu_{cov} = -0.32\,D$ using Slater functions. These values are not far from zero, and are much smaller in magnitude than the observed value of $+1.91\,D$[8].

Using hybridized orbitals with hydrogen-like wave-functions, the variation of μ_{cov} with percentage s character has been calculated and is shown in the accompanying diagram. While the curve shows the same general features as that obtained by Robinson for hydrogen chloride, there is a striking difference in that μ_{exp} for hydrogen fluoride is larger than the maximum value of μ_{cov}, namely, $+1.75\,D$, corresponding to 60 per cent s character. Thus the observed dipole moment cannot be explained solely in terms of hybridization. In this case, at least, it appears that ionic terms must be added to the wave function. Another point of interest is that, for both hydrogen fluoride and hydrogen chloride, approximately the same, small, amount of s character ($\sim$ 3 per cent) is required to give calculated values of the dipole moment of zero.

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E Whittle

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Identification of N-2 : 4-Dinitrophenylamino-Acids

Identification of the free amino-groups of proteins by converting them into N-2 : 4 dinitrophenyl derivatives was first introduced by Sanger[1]. Since then, several workers have evolved chromatographic methods for the separation of the dinitrophenyl amino-acids.

The regeneration of the parent amino-acid from its dinitrophenyl derivative is desirable both to confirm results from other methods and as a method in itself, since, as is well known, an excellent separation of free amino-acids can be achieved on paper using two solvents. Mills[2] attempted this by hydrolysing the dinitrophenyl derivatives with saturated baryta in a sealed tube. This method is applicable to the relatively long-chain amino-acids, but in our experience satisfactory results cannot be obtained in the case of amino-acids such as glycine, serine, threonine and aspartic acid

It has now been found that these short-chain amino-acids, as well as those with longer chains, can be very satisfactorily regenerated from their dinitrophenyl derivatives by heating with ammonia (0 880) in a sealed 'Pyrex' tube for 2 hr at 100° The solution is then evaporated to dryness and the residue dissolved in water and acidified with hydrochloric acid After ether extraction, the concentrated solution is applied to a paper chromatogram

It should be noted that dinitrophenyl lysine is not extracted into ether and so will be revealed on the chromatogram if the reaction is not taken to completion

All the amino-acids gave single strong spots having the correct R_F values in the solvents used, with the exceptions of cystine, proline, tryptophan and arginine In the case of cystine, decomposition occurred giving rise to several spots , the proline and tryptophan spots, although strong and of correct R_F value, were accompanied by two weak spots travelling slowly in butanol Dinitrophenyl arginine does not react under the above conditions

The technique has been used for investigating the terminal amino-groups of wool The amino-acids revealed were the same as those obtained by Middlebrook[3] and Blackburn[4] with the addition of leucine

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Photochemical Reduction of Pyridine Nucleotides by Spinach Grana and Coupled Carbon Dioxide Fixation

HIGHLY purified 'malic' enzyme from pigeon's liver[1] mediates a fixation of carbon dioxide through catalysis of reaction (1) When, by coupling with a suitable dehydrogenase system, triphosphopyridine nucleotide is continuously reconverted to its reduced form, malate is readily synthesized from pyruvate and carbon dioxide[2] Should illuminated chloroplast preparations be able to effect a reduction of pyridine nucleotides, then the photochemical reaction could be coupled to reductive carbon dioxide fixation by a well-defined enzyme system[2,3] Such a mechanism might operate in photosynthesis A 'malic' enzyme specific for triphosphopyridine nucleotide is present in the tissues of higher plants[4]

(1) Reduced form of triphosphopyridine nucleotide + pyruvate + CO_2 $\overset{(\mathrm{Mn}^{++})}{\rightleftharpoons}$ triphosphopyridine nucleotide + *l*-malate

Small amounts of *l*-malate are formed when washed green grana, prepared from spinach leaves by the method of Warburg[5], are illuminated in the presence of purified pigeon's liver 'malic' enzyme, pyruvate, carbon dioxide, small amounts of triphosphopyridine nucleotide, and a manganous salt Malate was determined enzymatically[1] As the accompanying figure shows, there is no reaction in the dark, or if either 'malic' enzyme or triphosphopyridine nucleotide is omitted *l*-Malate (10 micromoles), obtained in a similar experiment on a larger scale, was also identified with the specific adaptive 'malic' enzyme from *Lactobacillus arabinosus*[6] Tracer studies with carbon-14 dioxide confirmed the photochemical synthesis of malate by the above system The malate labelled with carbon-14 was isolated with the aid of carrier and identified both by paper chromatography and by specific decarboxylation with *L arabinosus* enzyme In each case, dark-control experiments showed no reaction

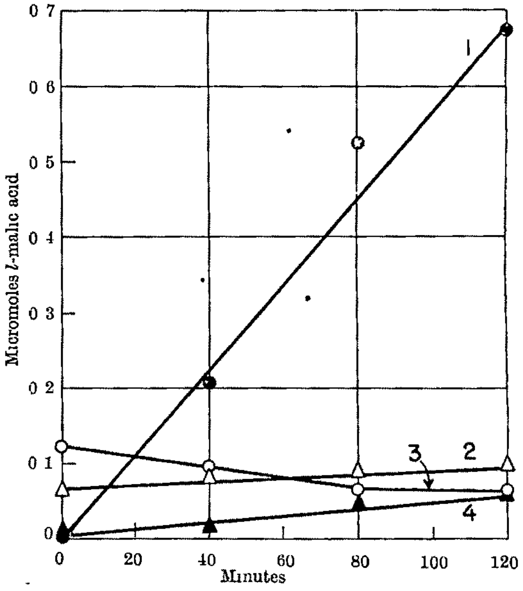
Photochemical reduction of diphosphopyridine nucleotide was demonstrated by the reduction of pyruvate to lactate[7] when washed green grana were incubated in the light with pyruvate and crystalline lactic dehydrogenase from rabbit muscle Lactic dehydrogenase catalyses reaction (2) Again, there was no reaction in the dark, or in the absence of either lactic dehydrogenase or diphosphopyridine nucleotide

(2) Reduced form of diphosphopyridine nucleotide + pyruvate $\rightleftharpoons$ diphosphopyridine nucleotide + lactate

Under otherwise strictly anaerobic conditions, the photochemical reduction of pyridine nucleotides evolved the theoretical amount of oxygen The oxygen produced was absorbed by chromous chloride[8] and the excess chromous ions were determined by iodometric titration

Our observations indicate that illuminated chloroplasts are able to catalyse the over-all reaction (3)

(3) H_2O + tri-(or di-)phosphopyridine nucleotide $\xrightarrow{\text{(light)}}$ 0 5 O_2 + reduced form of tri-(or di-)phosphopyridine nucleotide



The complete system (curve 1) contained green grana equivalent to 15 mgm chlorophyll, pigeon's liver 'malic' enzyme (40 units, ref 1), and the following components in micromoles potassium pyruvate, 150 , triphosphopyridine nucleotide, 0 46 , adenosine triphosphate (to protect the nucleotide from enzymatic cleavage), 7 5 , MnCl , 12 5 , $KHCO_3$, 200 , potassium phosphate, 750 , KCl, 1,000 Final volume, 20 c c , *p*H, 7 0 Curve 2, no 'malic' enzyme Curve 3, dark (flask wrapped in tinfoil) Curve 4, no nucleotide The flasks were flushed continuously with a gas mixture of 95 per cent nitrogen and 5 per cent carbon dioxide and shaken in a constant temperature bath at 15° The reaction was started by turning on the light At various time intervals 2 0 c c samples were withdrawn, acidified with sulphuric acid, centrifuged, and the supernatant neutralized and analysed for malic acid Results expressed per 20 c c of reaction mixture

Reaction (3) can then become coupled with either reaction (1) or (2) to bring about the reductive carboxylation of pyruvate to malate or its reduction to lactate[9] It is possible that chemosynthesizing bacteria may couple the oxidation of their specific substrates to carbon dioxide fixation through the mediation of pyridine nucleotides

We wish to thank Dr Seymour Korkes for his collaboration in part of this work

This investigation was aided by grants from the United States Public Health Service, the American Cancer Society (recommended by the Committee on Growth, National Research Council), the Office of Naval Research, and the Rockefeller Foundation

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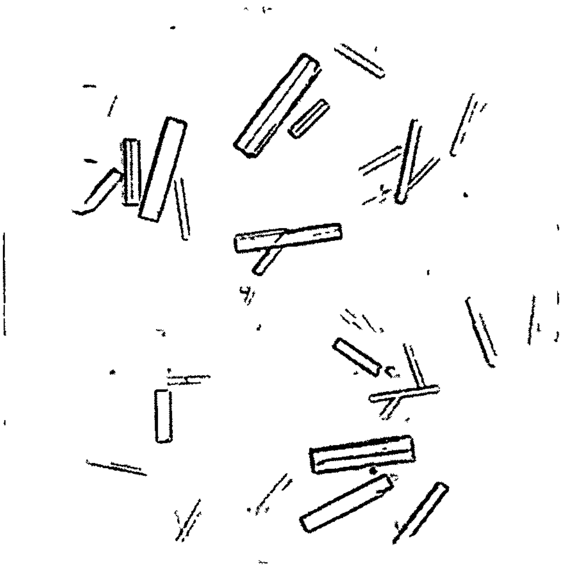
Crystallization of Fumarase

IN 1941 fumarase was claimed to have been isolated in crystalline form[1], but it has since been shown[2-4] that this crystalline material contained considerable quantities of lactic dehydrogenase and aconitase In this communication is reported the isolation of crystalline fumarase free of aconitase and lactic dehydrogenase, which has been shown to be a homogeneous protein by ultracentrifuge and electrophoresis criteria

Fumarase activity was determined by the spectrophotometric method described by Racker[4], the adsorption at 2770 A was used as a rough guide to protein concentration

Pigs' hearts, freed of fat and ligaments, were minced coarsely and washed well with tap water The washed mince was extracted with 0 02 *M* disodium hydrogen phosphate by homogenizing in a Waring blendor The resulting homogenate was centrifuged and the *p*H of the turbid supernatant adjusted to 5 2 After centrifuging off the large mass of inactive material, a clear reddish solution containing the enzyme in appreciable quantities was obtained Fumarase was adsorbed completely from this solution by calcium phosphate gel, and then eluted with 0 1 *M* phosphate buffer *p*H 7 3, containing 5 gm ammonium sulphate per 100 ml Ammonium sulphate fractionation was then carried out, the enzyme being contained in the 50–60 per cent saturation fraction This fraction was dissolved in water and dialysed over-night against distilled water A considerable degree of purification was then achieved by the addition of small amounts of calcium phosphate gel, sufficient to adsorb impurities but not fumarase The amounts of calcium phosphate necessary to do this vary from one preparation to another, and must be determined by activity tests for each case This is followed by another ammonium sulphate fractionation, the fraction between 50 and 60 per cent saturation again containing the fumarase This fraction was dissolved in the minimum amount of 15 per cent ammonium sulphate practicable, and a solution of saturated ammonium sulphate added drop by drop to faint turbidity This was done at room temperature and the solution was then allowed to cool down in the refrigerator After one to two days, crystals of fumarase separated out Crystallization is greatly speeded up by seeding with a few crystals from a previous preparation



Fumarase crystals from ammonium sulphate × 300

The crystals are very slightly soluble in distilled water, but can be dissolved readily in 0 01 *M* phosphate buffer *p*H 7 3 The activity reaches a constant value on recrystallization This value is about 0 55 moles fumarate converted to L-malate per minute per gram of crystals at *p*H 7 3 and 20° C In similar terms, the activity of the preparation of Laki and Laki was 0 14 moles at 39° C and *p*H 6 7 As the temperature coefficient of fumarase is rather high (preliminary estimations indicate a value about 2 5), the activity reported here is considerably greater than that of Laki and Laki Ultracentrifuge investigation at *p*H 7 34 and electrophoresis studies at *p*H 5 8, 7 34 and 8 1 showed only one protein component, of molecular weight 224,000 (assuming a value of 0 75 for the partial specific volume) From this value, the turnover number is calculated to be more than 100,000 at *p*H 7 3 and 20° C

Full details will be published elsewhere

The first stages in the purification were based on results obtained in an advanced class exercise under the direction of Drs M Dixon, E C Webb and S J Bach, of the Biochemistry Department, Cambridge I wish to thank Drs R Cecil and A G Ogston, of the Biochemistry Department, Oxford, for sedimentation constant and diffusion constant estimations, and to Dr B E Conway and Mr D W F James, of the Chester Beatty Research Institute, for electrophoretic mobility measurements. I am indebted to Dr. M. Dixon for suggesting the problem, and for advice and encouragement.

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Reversion of the Effect of Vitamin B_1 on Yeast Fermentation as a Result of Growth in the Presence of Cocaine

IN order to test the hypothesis (unpublished) that the habit-forming properties of certain drugs might be due to their ability to induce adaptive changes in the enzyme systems of cells and tissues, we have made comparative studies of the effects of cocaine on the respiration and fermentation of pure strains of yeasts, previously grown in the presence and in the absence of cocaine. A detailed report of this work will be published elsewhere. In brief, we find that cocaine in 0·004 *M* concentration depresses the respiration (*Torulopsis utilis*, var. *major*, type No. 6593) and the fermentation (*Saccharomyces cerevisiæ*, type No. 815) of the washed cells in glucose and phosphate buffer at *p*H 7·0, but is without effect at *p*H 6·0. Some degree of tolerance towards the drug appears to be established, as the depressant effect is less with cells that had been grown in the presence of cocaine.

It has been shown[1] that addition of vitamin B_1 to alkali-washed yeast in the presence of cocarboxylase stimulates the carboxylase activity. We have investigated the action of vitamin B_1 on the fermentation-rate of *S. cerevisiæ*, and we find that whereas the acid-washed yeast in 2 per cent glucose and *M*/20 phosphate at *p*H 7·0 is stimulated by 0·004 *M* thiamin, that which had been grown in the presence of 0·004 *M* cocaine is actually depressed by 0·004 *M* thiamin. In all these experiments, one- or two-day old cultures were used. They were grown at 25° C. in nutrient medium (20 gm. malt extract, 4 gm. K_2HPO_4, 1 gm. KH_2PO_4, and 30 gm. glucose per litre; *p*H 7·0) with and without cocaine (0·004 *M*).

Tubes of nutrient medium (*a*) with and (*b*) without cocaine (0·004 *M*) were inoculated with *S. cerevisiæ* and incubated at 25° C. After one or two days growth, the cells were separated by centrifuging, washed twice with *M*/20 phosphate buffer at *p*H 6·0, once at *p*H 7·0 and suspended in *M*/20 phosphate buffer containing 2 per cent glucose. 1·0 ml. of the yeast suspension, either (*a*) or (*b*), was placed in each fermentation vessel, together with 2·5 ml. of the buffer-substrate solution, with and without thiamin (0·0056 *M*). Production of carbon dioxide was measured in the Warburg apparatus at 30° C. The contents of the flasks were acidified by the addition of acid from their side-arms, at zero time for the controls, and one hour later for the experimental vessels. From the data so obtained the volumes of carbon dioxide produced in one hour were calculated.

In a typical experiment the yeast, previously grown in the absence of cocaine, produced in one hour 208 μl. carbon dioxide per ml. yeast suspension and 218 μl. carbon dioxide in the presence of added vitamin B_1, whereas that previously grown in the presence of cocaine produced 205 μl. carbon dioxide, but only 176 μl. carbon dioxide in the presence of vitamin B_1. The effect in this experiment of the added vitamin B_1 is therefore to stimulate the normal yeast (5 per cent activation) and to depress the cocaine-grown yeast (14 per cent inhibition).

Our experiments suggest that small quantities of cocaine can induce in living cells a change of marked physiological significance, and that the normal function of vitamin B_1 suffers some modification as a result. Further investigations are in progress and it would be premature at this stage to indulge in speculation as to the possible mechanisms involved. Similar studies with morphine and with nicotine are also in the course of investigation. We would like to emphasize that the medium we used is favourable to the healthy growth of the yeasts, and in this respect the conditions of our experiments are quite different from those usually employed in the study of enzyme adaptation, where the organisms are partly starved in order to force them to utilize some 'unnatural substrate' as a food.

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Existence of an Enzyme catalysing the Hydrogenation of Oximes in Silkworms

RECENTLY[1], I found that, in silkworms, nitrites, nitrates and ammonium salts could be converted into oximes, and suggested that this insect might utilize inorganic nitrogenous salts as nutritive substances. I have now been able to demonstrate that in the silkworm body there exists an enzyme which catalyses the transformation of oximes to corresponding amino compounds.

A typical experiment was as follows. Fifth instar worms from which the digestive organs were carefully removed were thoroughly washed with sterilized water. 3 gm. of washed bodies was mixed with 0·5 gm. of quartz sand, completely ground and diluted with water to 100 ml. The enzyme solution obtained contained no intact tissue cells or micro-organisms. For the determination of enzymatic activity, 5 ml. of this enzyme solution was mixed with a solution of pyruvic acid oxime or acetoxime and kept at 30° C. for 1 hr. Then the mixture was heated at 100° C. for 5 min., centrifuged after adding 0·05 ml. of saturated lead acetate solution, and the oxime content in the supernatant fluid was estimated. The total volume of reaction mixture was 10 ml., and in the control the enzyme solution was used after heating at 100° C. for 5 min.

Experiments showed that the enzyme activity was reduced to half by heating at 60° C. for 5 min. The optimum *p*H of enzyme action was about 6 and the optimum temperature 40° C. Under the experimental conditions mentioned above, half the oxime in 0·001 *M* solution was decomposed, and, even in the case of 0·1 *M* solution, about 20 per cent of oxime added was split. In the test solutions, free hydroxylamine was not detected. It was further observed that the amount of amino-nitrogen, which was determined according to Van Slyke's method, corresponded to the quantity of oxime nitrogen which had disappeared. I propose to name this enzyme tentatively 'oximase'.

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Pectic Enzymes produced by *Bacterium aroideæ*

REID[1] has recently described some properties of the pectic enzymes secreted by the fungus *Byssochlamys fulva*, and compared them with those described earlier by Beavan and Brown[2].

Similar studies are in progress here using *Bacterium aroideæ*. The bacteria are cultured in synthetic media, and solutions of the enzymes are prepared after precipitation from the cell-free culture fluid, dialysis and reprecipitation. Such preparations retain about 50 per cent of the activity of the original culture, macerate disks of potato tuber tissue 500 μ thick in fifteen minutes, have little pectin-esterase activity but rapidly reduce the viscosity of 0·5 per cent solutions of a high-methoxyl (9·15 per cent) citrus pectin at optimum *p*H. For example, one preparation reduced the specific viscosity from an initial value of 3·20 to 0·77 in one minute and to the low value of 0·15 after twenty minutes. These figures are in contrast with those of Beavan and Brown[2], who report their active preparations as macerating disks of potato tuber in eighteen hours and taking approximately ten hours to produce a substantial decrease in the viscosity of 1·0 per cent pectin solutions.

The properties of the viscosity-reducing enzyme secreted by this bacterium have been studied using as a measure of activity the inverse of the time taken for a 0·5 per cent solution of a high-methoxyl (9·15 per cent) pectin to reach a given value as determined from viscosity/time curves. On this basis a linear relation is obtained between enzyme concentration and activity. The enzyme is most active at high *p*H values, having an optimum between 8·5 and 9·0. Inactivation is rapid below *p*H 3·7. Thus, at *p*H 2·7 activity is reduced by 50 per cent after one minute and by 90 per cent after sixty minutes. Inactivation is also rapid at 60° C. and above, only 5 per cent of the original activity remaining after ten minutes at 60° C.

Prolonged dialysis at 5° C. leads to a considerable loss of activity. This is, however, completely restored by the addition of calcium ions. This effect is not produced by sodium, potassium, magnesium, strontium or barium ions. Enzyme preparations are normally prepared from cultures containing excess calcium carbonate; but similar activation by calcium is obtained after culturing the bacterium in media free from calcium ions.

With high-methoxyl pectins, the major viscosity changes take place with little increase in reducing power of the solution. There is little further increase even after treatment for twenty-four hours. Enzyme preparations behaving in this way still rapidly macerate disks of potato tuber. While high-methoxyl pectins have generally been used in these studies, the action of the enzyme on demethoxylated pectins is substantially the same.

The pectinolytic enzyme or enzymes secreted by *Bacterium aroideæ* therefore have properties substantially different from those of polygalacturonase, as described by Lineweaver *et al.*[3], and is peculiar in the following respects: (1) ability to act upon high-methoxyl pectins in the absence of pectin-esterase; (2) a high *p*H optimum; (3) activation by calcium ions; (4) inability to cause substantial increase in the reducing power of pectin solutions while causing very rapid reduction in viscosity.

The above work will be described in detail elsewhere.

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Enzymatic Inactivation of Secretin

THE inactivation of secretin by whole blood, cell-free plasma, serum and urine has been demonstrated by Greengard and Ivy[1,2] to be an enzymatic process. Because of the stability of their secretin preparations towards crystalline pepsin and trypsin and the absence of detectable proteolytic activity of blood, they concluded that 'secretinase' was not a proteolytic enzyme.

In this laboratory, however, it has been possible to show that 'secretinase' activity of plasma is activated by chloroform treatment and inhibited by soya bean trypsin inhibitor. Moreover, our preparations of secretin obtained by the procedure of Greengard and Ivy[3] are, in fact, inactivated by crystalline pepsin.

Secretin assays were carried out on dogs in the usual manner[3], and all *in vitro* experiments were conducted at 37° C. and *p*H 7·4. It was found that 0·4 mgm. secretin (*n*-butanol extracted fraction *SII*[3]) was inactivated by 4 ml. of a 1 : 1 dilution of citrated dog plasma in 0·05 *M* phosphate buffer within 1–3 hr. When chloroform-activated globulin, that is, serum protease prepared according to Christensen and McLeod[4], was tested similarly at eight times the dilution of the original plasma, the rate of inactivation was found to be increased several-fold (see table).

An amorphous trypsin inhibitor was prepared from soya bean by the same procedure as that used by Tauber *et al.*[5] for Lima bean. A concentration of 2 mgm./ml. inhibited maximally 0·4 mgm./ml. B.D.H. trypsin. When 2·5 mgm./ml. of this inhibitor was added to the plasma and chloroform-activated globulin solutions, the 'secretinase' activity was inhibited (see table).

Preliminary experiments in which up to 300 mgm. of amorphous trypsin inhibitor was injected intravenously into dogs showed, however, no effect on the secretin response of the animals. Further experiments are proposed in which crystalline preparations of the inhibitor will be used.

Although the evidence is insufficient to identify the 'secretinase' with the plasma protease, these experiments do suggest that, contrary to previous observations[1,2], the plasma inactivation of secretin proceeds by proteolysis, while the known proteolytic activity of urine[6] could likewise account for its 'secretinase' activity. It may be added that

Inactivation of Secretin by Plasma and Chloroform-activated Globulin Effect of Amorphous Trypsin Inhibitor

	Experiment*	Drop response to injection
Dog 1	Control secretin (100 μgm)	20
	Plasma (*a*) + secretin (100 μgm)	18
	Chloroform-activated globulin from (*a*) 1 7 dilution + secretin (100 μgm)	8
	Chloroform-activated globulin + secretin (100 μgm) + amorphous trypsin inhibitor	18
Dog 2	Control secretin (200 μgm)	15
	Plasma (*b*) + secretin (200 μgm.)	1
	Plasma (*b*) + secretin (200 μgm) + amorphous trypsin inhibitor	9

* The secretin solutions injected into Dogs 1 and 2 were incubated for ½ hr and 1 hr respectively

Hammarsten and Ågren[7] found that secretin prepared according to their methods was labile in the presence of proteolytic enzymes Our experiments, therefore, are in accord with their observations

The mechanism of inactivation by 'secretinase' does not appear to involve the liberation of amino-acids, since these could not be detected when plasma of secretin inactivated by chloroform-activated globulin was examined by the sensitive technique of paper-partition chromatography Unfortunately, the solubility of our secretin at *p*H 6 8 was not sufficiently great to enable measurements by indirect dilatometry[8] of any volume changes in the presence of plasma

It is of interest to note that chloroform-activated globulin inactivates vasopressin but does not affect oxytocin or hypertensinogen[9] The extension of the approach outlined above might well be of value in the investigation of the reported blood inactivation of other hormones such as pancreozymin[10] and cholecystokinin[11]

Facilities provided for the animal assays by Dr W T Agar, of the Department of Physiology, are gratefully acknowledged

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Action of Beryllium on Cells cultivated *in vitro;* Effect on Mitosis

The biological action of beryllium salts has lately aroused interest among embryologists[1-3] and pathologists[4] We have investigated the effect of beryllium (sulphate) acting for one to four days on tissue cultures of connective tissue and skeletal muscles (chick embryos) The final concentration varied from $M/400$ to $M/10^6$

With high dosage, the growth of the cultures is much inhibited or even stopped within 24 hr With intermediate concentration, the growth is slowed down, markedly after two or three days With low dosage ($M/10^6$, for example), there is practically no action for the first two days, and later the inhibition remains slight

On fixed and stained cultures, the decrease in the number of mitoses and the relatively high number of round metaphase cells are striking A few mitoses show chromosomic alterations , others are pycnotic

In living cultures observed with phase contrast at 38°, a few cells appear to undergo normal mitosis, whereas in others metaphase, always in spherical cells, is unduly lengthened up to several hours These metaphases can then follow three different courses they rarely undergo anaphase and telophase and divide into two apparently normal daughter cells , more often, either they degenerate and become pycnotic, or, without dividing, change back to elongated cells, and a resting nucleus—with nucleolus and nuclear membrane—reappears directly There is then, of course, nothing resembling normal anaphase and telophase

The transformation of fibroblasts and muscular elements into macrophages is abolished when the concentration of beryllium is $M/10^4$ or higher

The histochemistry of alkaline phosphatase[5], deoxyribonucleic acid (Feulgen reaction) and ribonucleic acid (methyl-green – pyronin, control with ribonuclease) was also studied in our cultures This showed mainly a complete inhibition of alkaline phosphatase at concentrations of $M/3{,}000$ and higher The inhibition is already marked at $M/10{,}000$ Biochemists have recently shown that beryllium inhibits strongly alkaline phosphatase[6] in tissue extracts, even at a concentration of $M/10^6$ when pure substances are used[7]

The present work shows that inhibition of growth and mitotic abnormalities are produced by long contact with beryllium ions It is suggested that the chemical mechanism of this action may be through a specific inhibition of enzymes concerned in phosphorus metabolism and probably in nucleoprotein metabolism

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Effect of Diet on Toxicity to Rabbits of the Toxic Factor from 'Agenized' Flour

The toxic factor present in 'agenized' flour was isolated[1] and later synthesized[2] by Moran and his colleagues at St Albans These workers had found that oral doses of about 5 mgm of the *dl*-compound or 2 mgm of the *l*-compound caused convulsions in more than 90 per cent of the rabbits dosed (they used animals of about 600–800 gm) Our first attempts to confirm the convulsive effect were completely negative doses up to 20 mgm of the *dl*-compound or 10 mgm of the *l*-compound had no effect whatever in our animals

When we compared notes with the St Albans workers, it was clear that the only condition which differed markedly between the two laboratories was the diet used for the rabbits

'Nottingham' Diet

Pellets (formula below), with a liberal supply of fresh greenstuff daily, and water freely

Bran	15 per cent
Grass meal	30 ,,
Ground nut cake	15 ,,
Linseed cake	10 ,,
Meat and bone meal	8 ,,
Barley meal	20 ,,
Sodium chloride	1 ,,
Calcium carbonate	1 ,,

'St Albans' Diet

Mixed diet of following formula, slightly moistened with water before use, with cod-liver oil twice weekly, and water freely

Flour, 85 per cent extraction, unfortified	1,200 gm
Bran	600 ,,
Crushed oats	600 ,,
Milk powder, spray-dried skimmed	150 ,,
Mineral salt mixture	60 ,,
Arachis oil	150 ,

The 'St Albans' diet was purposely formulated to have a high flour content and thus to resemble as closely as possible the diet used for dogs in the studies on canine hysteria It was only used for a short period before rabbits were dosed Rabbits kept as stock animals had the same diet plus greenstuff

The outstanding difference was the liberal supply of greenstuff in the Nottingham diet and its absence in the other when used for rabbits under test Dr Pace kindly supplied us with some of the St Albans diet for comparative tests, and we also examined the effect of a diet consisting of bran, oats and water only, and of the latter diet and the St Albans diet with added greenstuff Each diet was fed for at least four days before dosing The results of these experiments are shown in Table 1

Table 1 CONVULSIVE EFFECT OF TOXIC FACTOR IN RABBITS RECEIVING DIFFERENT DIETS

Diet	No of rabbits	Dose of compound	Result
Nottingham	2	18 mgm *dl*-	No effect
Nottingham	2	10 ,, *l*-	No effect
St Albans	3	10 ,, *dl*-	All convulsed in 24 hr
St Albans	3	5 ,, *dl*-	Two convulsed in 24 hr one unaffected
St Albans and greenstuff*	3	5 ,, *dl*-	Two convulsed in 48 hr one unaffected
Bran and oats	3	5 ,, *dl*-	Two convulsed in 48 hr one unaffected
Bran and oats	2 (adult)	20 ,, *dl*-	Both convulsed in 48 hr
Bran and oats and greenstuff*	2	5 ,, *dl*-	No effect

The rabbits weighed 600–900 gm , except the two marked "adult", which weighed 2 2 kgm

* The amount of greenstuff given was 150 gm per rabbit daily

A similar comparative test was made by the St Albans workers with the results shown in Table 2

Table 2 CONVULSIVE EFFECT OF TOXIC FACTOR IN RABBITS RECEIVING DIFFERENT DIETS

Diet	No of rabbits	Dose of compound	Result
St Albans	3	6 mgm *dl*-	All convulsed in 18 hr
Nottingham	3	6 ,, *dl*-	One convulsed in 20 hr two unaffected
Nottingham*	3	6 ,, *dl*-	One convulsed in 40 hr two unaffected

* These animals had continuous access to food , the others had access to food between 5 p m and 10 a m only

These results indicate that a dietary factor exists which prevents or reduces the convulsive effect of the toxic factor in rabbits. Fresh greenstuff appears to be a rich source of the dietary factor, and the Nottingham diet, which includes ample greenstuff, is also rich in the factor The St Albans diet is deficient in the factor, and the bran and oats diet appeared to be intermediate It is interesting that the addition of 150 gm of greenstuff daily to the St Albans diet for four days prior to dosage did not prevent the occurrence of convulsions, although it delayed their appearance, while the other diets containing greenstuff completely prevented convulsions The significance of this observation is unknown, as no food consumption records were kept , if the animals on the St Albans diet plus greenstuff did, in fact, consume the large amounts of greenstuff they received, the fact that they still became convulsed suggests the possibility of another substance in the St Albans diet which antagonized the greenstuff factor

Heathcote and Pace[3] have shown that the toxic effect of the factor from 'agenized' flour on the growth of *Leuconostoc mesenteroides* is reversed by glutamine , and as fresh greenstuff is rich in glutamine, it is possible that the dietary factor described above may be glutamine

We are indebted to Dr Moran and Dr Pace for their co-operation in this investigation and for the supplies of the synthetic toxic factor

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Pigments of *Penicillium herquei*

DURING a recent morphological study of *Penicillium herquei*, we became interested in the curious change in pigmentation induced by variation of the substrate, a phenomenon which had been reported by Bainier and Sartory[1] when the fungus was described in 1912 These workers observed that a yellow pigment was formed on potato, banana, carrot and Raulin's medium , on a medium rich in peptone the pigment was a beautiful blue Apparently no attempt was made at chemical characterization

As the initial step in a study of the relationship between these two pigments, we have isolated from the mycelium of a strain of *P herquei* (*NRRL* 2249) a crystalline red pigment On a broth medium consisting of 4 per cent dextrose and 1 per cent peptone ('Difco') in still culture, yields of crude pigment as high as 10 per cent of the weight of dry mat could be obtained in five days at 24° C

The pigment was isolated by ether extraction of the dried mycelium and purified by crystallization from benzene–petroleum ether (m p 225–227° decomp) Analytical figures are in agreement with the formula $C_{20}H_{20}O_7$ (found C, 64 4, 64 3 , H, 5 42, 5 42 , calc. for $C_{20}H_{20}O_7$ C, 64 51 , H, 5 41 , calc m w , 372 , found (Signer), 379).

Spectroscopic examination in 0 1 *N* hydrochloric acid–ethanol showed strong absorption at 3145 A ($E^{1\text{ per cent}}_{1\text{ cm}} = 1{,}214$, $E_M = 45{,}000$) Methoxyl values varied from 8 6 to 9 5 per cent (calc. for one methoxyl, 8 34 per cent), depending on the length of time of heating. This suggests degradation of the molecule with the formation of a higher alkyl iodide The presence of the methoxyl group was established by the formation of phenyl trimethylammonium iodide in good yield.

At room temperature the pigment is readily soluble in acetone and dimethyl formamide, fairly soluble in methanol, ethanol, ether, ethyl acetate and dioxane, difficultly soluble in carbon disulphide and benzene, and insoluble in carbon tetrachloride, petroleum ether and water It is extractable from ether with sodium hydroxide solution but not with aqueous sodium carbonate It gives a black colour with ferric chloride in alcohol

Catalytic reduction of the pigment in methanol in the presence of platinum stops with the formation of a yellow dihydro derivative, $[\alpha]_D^{25} + 24\ 8°$ (*c*, 0 8 in dimethyl formamide) In the crude form, the dihydro derivative no longer shows the 3145 A. peak but does exhibit strong absorption at 2370 A. (E_M 35,200)

Further studies are in progress, the details of which will be reported elsewhere.

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Factors involved in 'Chemotactism' of Leucocytes *in vitro*

THE polymorphonuclear leucocytes isolated from blood or an inflammatory exudate are able to respond to chemotactic stimuli ('tactism'). This property is readily demonstrated by the following technique[1] A suspension of starch granules, isolated from potatoes, is spread on microscope slides and the films fixed by drying A few drops of a suspension of leucocytes are placed on a slide so prepared, a cover-slip superimposed and the edges sealed with 'Vaseline' and wax The preparation is then placed on the stage of a microscope in a hot-box at 37° C Almost at once the leucocytes, attracted no doubt by soluble dextrin liberated into the medium, move towards the starch granules, and finally, within an hour, adhere to the surface of the latter in the form of regular crescents.

This phenomenon, although easy to demonstrate, only occurs under certain specific conditions It is precisely the determination of these that has been the subject of our investigation. Our experiments, the most recent of which will be reported in detail elsewhere, have shown that at least two conditions are indispensable. First, the leucocytes must be suspended in a favourable medium, and secondly, the cells themselves must be in a suitable state as regards surface properties and enzymatic equipment

(1) *The medium.* In our experience, the migration of leucocytes towards the starch granules never occurs in a medium which is simply mineral, such as normal saline or Ringer's solution[2]. Serum must be present, this need not necessarily be homologous (for example, guinea pig leucocytes can be suspended in rabbit serum) It is, however, obvious that a serum naturally toxic for the cells under investigation must be avoided (for example, guinea pig leucocytes must not be suspended in human serum[3]) We have further found that at least two of the normal constituents of serum must be present in sufficient concentration, namely, complement and inorganic calcium.

(*a*) *Complement* Leucocytes suspended in serum, the complement of which has been eliminated by age, heating or absorption with bacteria[2], remain alive but do not move towards the starch granules Similar results are obtained with serum the complement of which has been partially destroyed by fresh yeast or ammonia It would thus appear that all four constituents of complement are indispensable for the production of 'tactism' *in vitro.*

(*b*) *Calcium ions* In a serum medium from which the calcium has been precipitated by the addition of 10 mgm. per ml of sodium citrate or oxalate, the leucocytes continue to form a few pseudopodia, but they do not migrate towards the starch granules[4] Since citrate inactivates complement, the inhibition of 'tactism' caused by addition of sodium citrate might result from this effect, rather than from the precipitation of calcium The same, however, cannot be said of oxalated serum. Furthermore, the simple addition of calcium to either of these media is sufficient to re-establish the phenomenon

(2) *Condition of cells.* We have found it possible to inhibit completely the phenomenon of 'tactism' even in a serum medium rich in complement and calcium ions by modifying directly the state of the leucocytes.

(*a*) *Surface* Leucocytes, which after being in contact with olive oil for two hours are re-suspended in serum, appear morphologically normal, but remain round in the presence of starch granules towards which they no longer migrate. Although we have been able to show that the electric surface charge of the cells has not changed, it seems likely that the observed inhibition of 'tactism' is due to a modification of the cell surface

(*b*) *Cell enzymes* One of us (J. Lebrun) has shown that the addition of certain enzyme inhibitors to the medium, without, of course, killing the leucocytes, suppresses their capacity to respond to chemotactic stimuli The following fourteen inhibitors, in the concentrations indicated, have been found to have this effect. sodium fluoride ($M/4$), sodium pyrophosphate ($M/200$), cysteine ($M/10$), thioglycollic acid ($M/32$), sodium fluoracetate ($M/20$), malonic acid ($M/7$), sodium cyanide ($M/90$)[5], sodium azide ($M/7$), hydroxylamine ($M/15$), sodium diethyldithiocarbamate ($M/3$), dithizone (half saturated), *ortho*penantroline (one-third saturated), sodium bisulphite ($M/8$), urethane ($M/5$)

Of these inhibitors, the first two also precipitate calcium and the next four inactivate complement It is possible, therefore, that with these compounds the suppression of 'tactism' is secondary to their effect on the medium The remaining eight inhibitors, however, have no such effects, and it seems probable that they act directly on the enzymes of the leucocytes. A diminution in the phagocytic power and respiration of the latter sometimes, but not always, accompanies the inhibition of 'tactism'

In the light of these results, it would appear that enzyme reactions play an important part in the phenomenon of 'tactism' *in vitro* It is conceivable, for example, that the abundance of peroxidase in polymorphonuclear cells[6] as compared with lymphocytes is related to their migratory power The nature of the enzymes involved, however, remains an open question and will form the basis for future investigations.

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Effect of Partial Acetylation on Jute

PARTIAL acetylation as a means of arresting the development of the yellow to brown colour, produced by photochemical reactions on irradiating bleached jute with a mercury vapour lamp, has been suggested by Peill[1], and Callow and Speakman[2]. The development of this undesirable shade in untreated and bleached jute has been postulated by the latter as mainly due to a sequence of reactions involving the lignin molecule, presumably through the formation of *o*-phenols and subsequent conversion to *o*-quinones. These authors are also of opinion that some discoloration may be caused by the polymerization of furfural liberated from pentosans, or result from condensation reactions between furfural and phenolic groups of lignin. On acetylation, however, the phenolic and alcoholic hydroxyl groups in jute are blocked, and consequently the possibility of the above reactions leading to discoloration is avoided.

During partial acetylation of a cellulosic fibre, the reaction is supposed to take place in a topochemical fashion, and unless the acetylated layer is removed by some suitable solvent, the reaction is expected to be confined to the surface layer of the fibre. Jute is basically composed of cellulose, hemicelluloses, and lignin, and the relative proportion of their hydroxyl groups occurring at the surface layer, which are free for acetylation, is not known. It was therefore considered of importance to determine the relative amounts of acetyl groups which reacted with individual fibre components during the acetylation of jute.

The untreated or bleached jute fabric (3 gm.), when subjected to partial acetylation by refluxing the material with a mixture of acetic anhydride (30 gm.) and xylene (30 gm.) in the presence of sulphanilic acid (0.06 gm.) as a catalyst for four hours, during which time a definite equilibrium was reached, showed that a high content of acetyl had been introduced. Under the same conditions, however, only a smaller fraction of the available acetyl reacted either with cotton or α-cellulose isolated from jute. This greater affinity of jute for acetyl groups is therefore most likely due to the presence of hemicelluloses or lignin or both. Since holocellulose isolated by two successive treatments with sodium chlorite solution (0.7 per cent) at *p*H 4, at 100° C., takes up a greater amount of acetyl (see table) than when the hemicelluloses are eliminated from jute fabric by boiling with 10 per cent caustic soda solution, which also removes only a small quantity of lignin, it seems likely that when untreated or bleached jute is acetylated, the hemicelluloses are responsible for more of the acetyl groups attacked compared with lignin. Furthermore, as the isolated jute α-cellulose is capable of reacting with only a small amount of acetyl, it is probable that, during acetylation of untreated or bleached jute, the cellulosic component plays a less important part compared with hemicelluloses and lignin.

Sample	Loss in wt. due to chemical treatment (per cent)	Increase in wt. due to acetylation (per cent)*	Initial acetyl content of the material (per cent)*	Introduced acetyl content (per cent)*
Purified cotton	—	4.3	Nil	4.36
Jute α-cellulose	39.7	3.3	0.79	4.60
Dewaxed untreated jute	—	11.9	5.94	13.55
Jute bleached by treating successively with NaOCl and H_2O_2	8.2	13.5	3.09	14.52
Jute holocellulose	16.8	11.7	4.06	14.28
Dewaxed jute fabric boiled with alkali	26.6	10.8	0.34	11.95

* Expressed on bone-dry unacetylated material.

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'Lampbrush' Fibres in the Chromosomes of *Chrotogonus incertus* Bolivar

THE meiotic chromosomes of the grasshopper, *Chrotogonus incertus* Bolivar (collected at Allahabad), assume typical 'lampbrush' appearance at pachytene, which condition persists to the end of diakinesis, but disappears completely at the first metaphase. This condition has been reported by Hsu[1] in two different species of grasshoppers, and, judging from illustrations, it seems to have been observed in grasshoppers by other investigators also, even though they do not explicitly describe it[2,3]. Hsu[1] has put forward an ingenious theory, based essentially on Goldschmidt's[4] interpretation of the 'lampbrush' chromosome, which links up spiralization, heteropycnosis and the formation of 'lampbrush' processes. According to him, heterochromatinic heteropycnosis is not due, at least not entirely, to differential nucleic acid synthesis[5], but to a difference in the capacity to undergo cyclic condensation. Negative heteropycnosis results from the fact that the intracellular conditions permit the growth of 'lampbrush' fibres on the *X*-chromosome, whereas the autosomes become compactly coiled. Positive heteropycnosis results when the conditions are reversed; the *X*-chromosome undergoes condensation, but not the autosomes, which, in consequence, show the 'lampbrush' fibres. Polymerization of the nucleoprotein, he claims, causes the chromosomes either to be coiled or show 'lampbrush' fibres. Now in the spermatocytes of *Chrotogonus*, late diakinetic chromosomes, although considerably condensed and consequently much shorter than the pachytene threads, are provided with 'lampbrush' fibres similar in size and shape to those of the earlier stages. So, condensation (spiralization) and 'lampbrush' formations can exist simultaneously in a chromosome. Further, the negatively heteropycnotic X-chromosome of early spermatogonial metaphase is not reported to possess 'lampbrush' fibres[6,7]. Also, in certain special cases, the rates of reproduction of euchromatin and heterochromatin have been found to be appreciably different[8], so the differences between them may be more fundamental than Hsu's[1] hypothesis assumes. In *Chrotogonus* the 'lampbrush' fibres spring from deeply stainable beads on the chromonemata. Such beads Serra[9] claims to have resolved on careful observation, into parts of a helicoidal coil of four chromonemata. He considers the 'hairs' of such chromosomes to be rod-like structures of nucleoplasm deposited on the chromonemata, and, in a lesser degree, the coils of chromonemata themselves. In view of the fact that the staining properties of the 'lampbrush' fibres are similar to those of the rest of the chromosome, and the almost unstaining nucleoplasm at these stages is markedly poor in nucleic acids, Serra's[9] view is scarcely plausible. It is more in consonance with known facts to consider the 'lampbrush' bristles as arising from the peripheral nucleoprotein matrix surrounding the chromonemata[10].

A peculiar property of heterochromatin is its capacity to undergo non-homologous pairing, which seems to be accentuated on subjecting the animals to cold. Chaudhuri and Manna[7] describe Feulgen-positive threads connecting different bivalents and X-chromosome at the first metaphase and earlier stages in a grasshopper. They seem to consider this phenomenon to be of the same order as the non-homologous pairing in the chromosomes of the salivary gland of *Drosophila* larva. In *Chrotogonus*, distinct connexions between bivalents do not exist at any stage, apart from occasional entanglement of the 'lampbrush' fibres of different chromosome pairs. Such an entanglement of 'lampbrush' fibres has also been reported by Slizynski[11] in the mouse. It is not unlikely that the interconnecting threads reported by Chaudhuri and Manna[7] are identical with the 'lampbrush' fibres.

In *Chrotogonus*, in a fair proportion of cells, a supernumerary bivalent is present at metaphase. It is quite small—slightly smaller than the smallest pair of the complement. Another interesting, though comparatively rare, feature is syndiploidy. High-multiple bivalents are sometimes found. In one spermatocyte as many as forty-five bivalents and five X-chromosomes (no quadrivalents) were counted at the metaphase, the normal number being nine bivalents and one X-chromosome. The ultimate fate of such giant cells remains untraced; but it is unlikely that they give rise to normal spermatozoa.

Staining with Unna's pyronin–methyl green mixture gives inconstant results. The nuclei of spermatozoa always stain violet, indicating the presence of ribonucleic acid in addition to deoxyribonucleic acid. Although this mixture is supposed to stain deoxyribonucleic acid green and the ribonucleic acid red[12], this is not realized in this material. Mann's methyl blue eosin, on the other hand, always stains metaphase, anaphase and telophase chromosomes (both meiotic and mitotic) bright red, and the prophase chromosomes blue. At diakinesis chromosomes are stained partly red, but the greater portion is still bluish. This would seem to indicate that the chromosome, as it passes from prophase to metaphase, goes through a qualitative change in its nucleoprotein content.

A full account of this work will be published elsewhere.

I wish to thank Prof. C. H. Waddington, who gave me facilities in his Institute to complete this work, and was kind enough to read the manuscript.

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Cellulase and Chitinase of Earthworms

Little is known of the digestive enzymes of the earthworm. The presence of protease, amylase and lipase has been reported in the gut contents in isolated instances. Since up to 10 per cent of the top four inches of soil in grassland may pass through the intestines of worms in a year[1], their digestive abilities are of a relevance to transformation of soil organic matter.

Using a viscometric method[2], it has been found that water extracts of seventeen species of British earthworms contain an enzyme reducing the viscosity of solutions of sodium carboxymethylcellulose at *p*H 5, which is presumptive evidence of the presence in the extracts of cellulase. Some extracts have also been shown to produce soluble reducing sugar when incubated in the presence of finely divided cellulose. In twelve species of which sufficient material was available, the presence of chitinase was demonstrated viscometrically using a solution of chitosan hydrochloride at *p*H 5, and confirmed in some by the production of acetylglucosamine from finely divided chitin.

The amount of these enzymes on a fresh-weight basis may be of the order of that found in the snails *Helix aspersa* and *H. pomatia*, probably the most active source of animal chitinase and cellulase known at present. The amount of cellulase on a fresh-weight basis varies by a factor of about 500 in the species examined; but much of this variation may be due to varying losses of enzyme by precipitation or adsorption in the preparation of the water extracts of whole worms. In a single species, *Octolasium cyaneum* Sav., the cellulase content per gram of worm varied by a factor of 10 between eight individuals.

It is probable that the enzymes are produced by the worm itself, for extracts of the wall of the fore-half of the intestine of *Lumbricus terrestris* L., which had been dissected out and washed free of gut contents, contained both enzymes. Little or none was found in the extracts from pharynx, œsophagus and crop, and gizzard, and extracts of the hind-half of the intestine contained a tenth of the cellulase and a third of the chitinase found in the fore-half extracts These findings do not, of course, exclude the possibility that cellulase and chitinase may also be produced by organisms living in the intestine

The following species were investigated, those in which lack of material prevented the detection of chitinase being placed in brackets *Allolobophora caliginosa* Sav , *A chlorotica* Sav , *A icterica* Sav , *A longa* Ude, *A nocturna* Evans, (*Bimastus eiseni* Levins), (*Dendrobœna mammalis* Sav), (*D rubida* Sav), *D subrubicunda* Eisen, *Eisenia fœtida* Sav , *E rosea* Sav , (*Eiseniella tetrœdra* Sav), (*Lumbricus castaneus* Sav), *L rubellus* Hoffmstr , *L terrestris* L , *Octolasium cyaneum* Sav , *O lacteum* Oerleg I must thank Prof L -G Rommel, of the Experimentalfaltet, Stockholm, who suggested this problem, and Mr J E Satchell, of this Station, who supplied the identified species of worms

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Mating Behaviour in Sheep

IN the course of vertebrate evolution, patterns of sexual behaviour of increasing complexity involving the interaction of anatomical, neural and psychological components have arisen, the main tendency of which has been to ensure greater economy in the production and greater protection of gametes In the female mammal, the restriction of copulation to the œstrous cycle provides economy of the male gametes and prevents the exhaustion of the male The manifestation of œstrus may be under the control of both œstrogens and progesterones[1,2], while in the ewe androgens may be implicated[3] The sex drive of the male is not constant, due to varying thresholds of response[4] The patterns of mating behaviour may, or may not, be dependent on additional forms of hormonal control[5]

Ewes of six breed groups and three age groups were running with rams of three breed and three age groups, either on pasture or in enclosures The rams were changed from one group of ewes to another in rotation, and mating behaviour has been observed during three successive breeding seasons

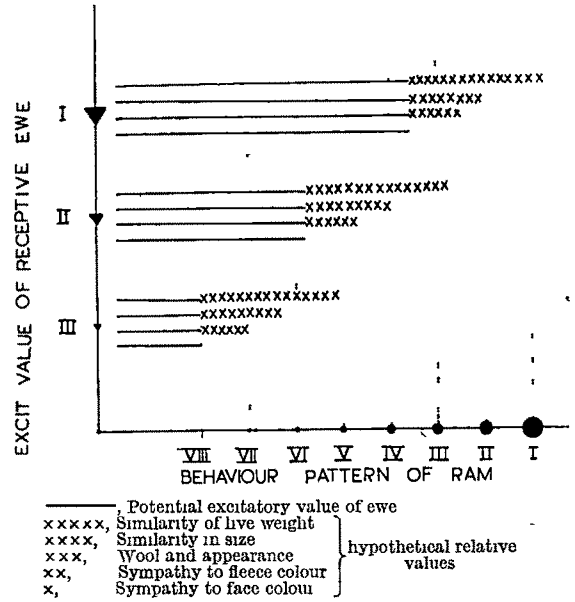
The pattern of mating behaviour of the ewe was the same towards all the rams , but ewes of different breeds and ages exhibited three different intensities of sex drive (see table)

The intensity of sex drive of the rams was considerably modified by the breed of the ewe The rams showed eight behaviour patterns towards different breed and age groups of ewes as follows (I) fierceness, erection, protrusion and ejaculation before mounting , (II) intense interest and normal copulation , (III) coitus and ejaculation with less certainty of penetration , (IV) mounting with considerable efforts to penetrate , (V) mounting with no efforts at actual copulation , (VI) exploring the genitalia with no attempts to mount , (VII) following the ewe with no attention to her genitalia , (VIII) no interest at all

BEHAVIOUR PATTERNS OF EWES

Grades of sex drive	Sexual pattern of receptive ewe	Breed
(I) High intensity	Searching for the ram, persisting in being close to him and readily accepting coitus	Dorset Horn and Suffolk
(II) Medium intensity	Approaching the ram only when the latter was running near the flock, and accepting service	Romney Marsh, Border Leicester and Welsh Mountain × Dorset Horn
(III) Low intensity	No attempt to approach ram, but accepted service when the latter made sexual approaches	Blackface Mountain, Welsh Mountain and ewe lambs

These different mating patterns of the rams were a result of different excitatory values exhibited by the ewes The excitatory value of the ewe varied with the breed, age, live-weight, size, colour of the fleece and face and the general appearance, and possibly also with the coarseness of the wool In general, the mating patterns of the ram seem to be the same as those exhibited in the male rabbit[4]


EXCIT VALUE OF RECEPTIVE EWE
I
II
III
xxxxxxxxxxxxxxx
xxxxxxxx
xxxxxx
VIII VII VI V IV III II I
BEHAVIOUR PATTERN OF RAM
———, Potential excitatory value of ewe
xxxxx, Similarity of live weight
xxxx, Similarity in size
xxx, Wool and appearance
xx, Sympathy to fleece colour
x, Sympathy to face colour
hypothetical relative values

A relationship between the sex drive of a particular ewe or a particular breed of ewes and the behaviour pattern of the ram is suggested in the accompanying diagram Sex drive of the receptive ewe is indicated on the vertical ordinate, and the different behaviour patterns exhibited by the ram are indicated horizontally A potential excitatory value of the ewe is represented by a continuous line which varies in length according to the grade of sex drive of the breed (see table) Other additional factors are involved in determining the actual excitatory value of the receptive ewe, such as the similarity in size and live-weight between the ram and the ewe, the appearance of the wool, the sympathy that the ram shows towards the colour of the face or the fleece of the ewe These factors appear to vary in importance and they are represented in the diagram by units (x) The actual excitatory value of a particular ewe (for a given ram) is obtained by adding a number of these units to her potential excitatory value The number of such units added depends on the ram used In other words, if a Dorset Horn ewe (grade I, see table) is mated to a Suffolk ram a little bigger in size and live-weight and having sympathy towards the colour of her face and the colour and texture of her fleece, the ram experiences fierce copulation of grade (I) If the Dorset Horn ewe is mated to a Welsh Mountain ram lamb of smaller size, the ram behaves only as grade (V) or (VI). Also, if a Welsh Mountain ewe with her rump cleared of wool is mated to a heavy Border Leicester ram, the latter will probably show no sexual interest[5].

This work is being carried out in the Animal Research Station, Cambridge, while on study leave from the Fouad I University of Egypt. Detailed results will be published elsewhere. I wish to thank Dr. John Hammond for his advice and encouragement and Dr. Arthur Walton for criticism.

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A Sanskrit Work on Angling of the Early Twelfth Century

BASHFORD DEAN'S "Bibliography of Fishes" records an anonymous work entitled "Dit Boecxken leert hoe men mach voghelen vanghen metten handen. Ende hoe men mach visschen vangen metten handen. Ende oeck andersing. Ende oeck tot wat tyden vanden iare dat een yeghelyck visch tsynen besten is. Hier eyndet een boecxken dat seer profitelijck is voor allen visschers, ende vogheleers" and published at Antwerp in 1492 as the earliest known work on angling. In 1872, Alfred Denison, as editor, published "A literal translation into English of the earliest known book on fowling and fishing, written originally in Flemish and printed at Antwerp in the year 1492". The editors of Dean's "Bibliography of Fishes" have supplied the following useful information concerning another earlier book on angling: "This Flemish tract appears to have priority over the 'Boke of St. Albans', as far as fishing is concerned; that is, as a printed book. There are a number of early German versions, appearing under the title of 'Buchlin' or 'Fischbuchlin', published between 1552 and 1700. One of these is included in the Fischbach of Gregory Mangolt, published at Zurich in 1598. Three other editions are known: one in 4°, without place or date, having an identical title; the other, slightly changed in verbiage, in 1583 without place; and the third in 1584."

In the fourteenth edition of the *Encyclopædia Britannica* (1, p. 932) more light is thrown on the "Boke of St. Albans", a part of the second edition of which was published in 1496. The manuscript is stated to be of the earlier part of the fifteenth century. There are, however, possibilities of still older manuscripts of this work.

The publication of the Sanskrit manuscript of "Mānasōllāsa" by King Sōmēśvara, son of King Vikramāditya VI of the later Chaḷukyas, in the Gaekwad's Oriental Series (Publication No. XXVIII, Baroda, 1925), has brought to light a chapter on angling which gives details, almost modern in practice, about this pleasant pastime. "Mānasōllāsa" is an encyclopædic work and was composed in A.D. 1127. The kingdom of Sōmēśvara comprised practically the whole of the Deccan plateau and included the Godavari, Narbada, Tapti and Kistna river systems. It included the Maratti, Tamil and Telugu peoples and stretched from the east to the west coast of India.

The chapter on angling is entitled "Matsyavinōda", the pastime of angling. As many as thirty-seven species of Indian sporting fishes are mentioned. These are divided into marine, freshwater and anadromous kinds. They are then further divided into scaly and scaleless varieties, and each group is still further divided into large, medium and small according to size. From the etymological meanings of the fish names and other particulars given in the work about each kind, it has been possible to determine with a fair degree of certainty thirty-three out of thirty-seven species. The fishing tackle is dealt with under the three main components, namely, line, rod and hook. Various types of fibres for making a line are suggested, and their relative merits discussed. A solid bamboo shoot or a branch of a mangrove tree are suggested as suitable material for making a rod; types of suitable iron hooks are described.

For different groups of fishes different prescriptions are given for preparing ground baits, and methods of feeding various species are separately described. Sōmēśvara also gives hints on the actual fishing technique and refers to details of ground bait, tackle, float, bait, casting the line, fish bite, striking a fish and playing a fish.

By studying inscriptions of irrigation tanks in southern India, it has been possible to give an evolutionary sequence of fishing in such tanks. There are inscriptions of the fifth and sixth centuries A.D., showing that irrigation tanks were maintained from the revenue derived from paddy cultivation. In an inscription of the middle of the tenth century, there is mention of a fisherman, but he is assigned the work of supplying wood for the repairs of boats used for the desilting of tanks, and is paid for his labour in paddy. A Tamil inscription of A.D. 1112 mentions revenue derived from fishing for the maintenance of the tank, which shows that the art of pond culture and angling had already progressed fairly far. King Sōmēśvara composed his "Mānasōllāsa" in 1127. In all the inscriptions of the thirteenth to the sixteenth century, one finds that fishery revenue from irrigation tanks was sufficient for their maintenance. From this historical narrative, the art of sport fishing can definitely be assigned in southern India to the middle of the tenth century.

The work referred to here shows that the art of angling was developed in ancient India to a very high standard, for the methods described therein are quite in line with those used by anglers in India today. The gipsies of Europe, who use Mongolian, Hindi and other fragments of Asiatic languages, to-day practise the same methods as those described by King Sōmēśvara, and it is likely that they wandered from India to Europe and spread the art of angling there. The so-called 'Thomas Detective float', a peacock feather type of float, is described in "Matsyavinōda" and is not an innovation of the nineteenth century. Full details of this work, with an atlas of fishes referred to therein, will appear in the *Journal of the Royal Asiatic Society of Bengal* in due course.

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Evidence for the Natural Radioactivity of Indium

A CONSIDERATION of the energetics of radioactive decay shows that two isotopes of the same mass number but neighbouring atomic number cannot both be stable if the rest mass of the neutrino is zero A number of such neighbouring isobaric pairs exist in Nature, in some cases the expected radioactivity has been found in one member of the pair, with a period of decay comparable to, or longer than, the age of the earth (for example, the well-known case of $^{40}_{19}$K) The two naturally existing isotopes of indium—$^{113}_{49}$In and $^{115}_{49}$In (abundances 4 5 and 94 5 per cent respectively)—are each members of such isobaric pairs, the first with $^{113}_{48}$Cd, and the second with $^{115}_{50}$Sn Accordingly, it was decided to search for radioactivity among these elements, as none had hitherto been found

Positive results were obtained with indium Using Geiger counters with easily changeable cathodes, a definite increase in counting-rate above the background-rate was detected when indium cathodes were used The increase was of the order of 15 pulses per minute from a cathode of effective area 75 sq cm and thickness 100 mgm /cm ^{2} Indium samples of different origin and of spectrographic purity were used and gave consistent results The possibility that the counts were due to α-particle contamination was excluded by the results obtained using proportional counters and from absorption measurements

I first tried to find if the radiation from indium could be identified with the characteristic K X-rays of cadmium, which would be expected to follow the decay of $^{113}_{49}$In to $^{113}_{48}$Cd by K-orbital electron capture The experiments were carried out with krypton-filled counters which had an efficiency nearly unity for these X-rays The results were negative, and showed (in agreement with the results of previous workers[1]) that the half-life for the decay of $^{113}_{49}$In to $^{113}_{48}$Cd by K-capture must be greater than 10^{14} years

There remain two possibilities first, the decay of $^{115}_{49}$In to $^{115}_{50}$Sn by β-emission, secondly, the decay of $^{113}_{49}$In to $^{113}_{48}$Cd by L-orbital electron capture Most of the radiation, in fact, was found to consist of β-rays The half-value absorption thickness through aluminium under bad geometry was found to be about 10 mgm /cm ^{2}, indicating that the energy of the β-rays must be of the order of a few hundred kilovolts The interpretation of these results would appear to be that $^{115}_{49}$In decays by β-emission to $^{115}_{50}$Sn with a half-life of the order of 10^{14} years

The second possibility—that part of the radiation may be L X-rays following the decay of $^{113}_{49}$In by L-capture—is of considerable interest Outer electron capture should always accompany K-capture, but, in general, only to a small extent It is consequently very difficult to detect, and, in fact, has only been observed in the case of $^{37}_{18}$A, using proportional counter technique[2] In some exceptional circumstances, depending on the difference in energy and angular momentum between the two nuclei involved, it is possible that the probability of L-electron capture is greater than that of capture from the K-shell Using counters with different gas fillings and hence different efficiencies for cadmium L X-rays, results were obtained which were consistent with the hypothesis that a small part of the radiation consisted of cadmium L X-rays, but owing to the small counting-rates involved, the results cannot be regarded as conclusive evidence for this process Assuming L-capture, one arrives at a half-life of the order of 10^{12} years for the decay of $^{113}_{49}$In in this way

In order to arrive at a more conclusive result on the L-capture process, the use of indium trimethyl vapour as a filling in a proportional counter has been considered

This work was carried out at the Cavendish Laboratory, Cambridge, during 1947 and 1948 I would like to express my thanks to Prof O R Frisch for his encouragement of this study A detailed account of the experiments will be published in the near future

Addendum After this note was written, I had the opportunity (through the kindness of Dr J V Dunworth) of reading an account of more recent and independent work of Libby and Martell (unpublished), using indium samples with isotopic enrichment Their results essentially confirm the β-radioactivity of $^{115}_{49}$In No conclusive evidence for orbital capture in $^{113}_{49}$In has been found

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Nov 27

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[1] Russinow and Igelnitsky, *C R Acad Sci U R S S*, **47**, 333 (1945), **49**, 343 (1945)

[2] Kirkwood, Pontecorvo and Hanna, *Phys Rev*, **74**, 497 (1948)

Lattice Vibrations and Optical Waves in Ionic Crystals

LATTICE vibrations in ionic crystals are usually treated with the unretarded Coulomb forces Despite some discussions in the existing literature[1,2], the precise nature of the effect due to retardation remains unknown We have found that explicit solution of the problem is possible for diatomic crystals with optical isotropy, mainly because the lattice vibrations concerned are very long waves, for which the lattice behaviours can be described by the following equations[3]

$$\mathbf{w} = -\omega_0{}^2\mathbf{w} + \left(\frac{\varepsilon_0 - \varepsilon_\infty}{4\pi}\right)^{1/2}\omega_0\mathbf{E}, \qquad (1)$$

$$\mathbf{P} = \left(\frac{\varepsilon_0 - \varepsilon_\infty}{4\pi}\right)^{1/2}\omega_0\mathbf{w} + \left(\frac{\varepsilon_\infty - 1}{4\pi}\right)\mathbf{E}, \qquad (2)$$

where $\mathbf{w}$ is the displacement of the positive ions relative to the negative, multiplied by the square root of the ratio of the reduced mass of the ions to the lattice cell volume, $\mathbf{P}$ and $\mathbf{E}$ are the dielectric polarization and the electric field, ε_0, ε_∞ and ω_0 are the static and high frequency dielectric constants and the infra-red dispersion frequency (circular)

As shown elsewhere[3], if the electric field in the lattice is treated according to electrostatics (equivalent to unretarded forces) by considering the equations (1) and (2) in conjunction with

$$\nabla \cdot (\mathbf{E} + 4\pi\mathbf{P}) = 0, \qquad (3)$$

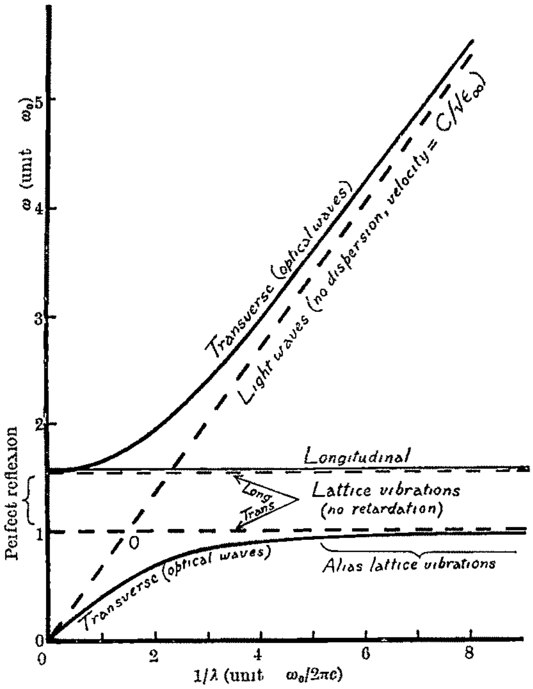
one obtains the *usual* longitudinal ($\omega = (\varepsilon_0/\varepsilon_\infty)^{1/2}\omega_0$) and transverse ($\omega = \omega_0$) lattice modes[4-6], which are represented by dotted lines in the $\omega \sim 1/\lambda$ graph In order to take account of the retardation effect, one has to bring in the remaining Maxwell equations

$$\nabla \cdot \mathbf{H} = 0, \qquad (4)$$

$$\nabla \times \mathbf{E} = -\frac{1}{c}\dot{\mathbf{H}}, \qquad (5)$$

$$\nabla \times \mathbf{H} = \frac{1}{c}(\dot{\mathbf{E}} + 4\pi\dot{\mathbf{P}}) \qquad (6)$$

These equations, we note, necessarily bring the radiation field into the picture as well Consider the case when all the ions are held fixed in their equili-



brium positions equation (1), being the equation of motion for the ions, can now be discarded and the w term drops out from (2) The solutions of (2)–(6) are then simply the light waves suffering only refraction due to electrons (velocity = $c/\sqrt{\varepsilon_\infty}$), these solutions are also represented by a dotted line in the graph The complete equations (1)–(6) thus obviously describe the combined system lattice vibrations + radiation field As regards the former, the equations should lead to the retardation effect, and, as regards the latter, they should lead to the infra-red dispersion

The solutions of the equations (1)–(6) are the longitudinal and transverse vibratory modes plotted as solid curves in the accompanying graph The longitudinal lattice modes are seen not to be affected by the retardation effect As regards the transverse solutions, the situation can be interpreted roughly as follows At the intersection point O, the light wave and the *usual* transverse lattice modes have the same frequency and are in resonance, corresponding thus to the strongest mutual perturbation The resonance tails off towards the right, where we find, indeed, a branch of the transverse solutions approaching the *usual* transverse lattice modes On the other hand, the transverse vibrations as usually understood are non-existent on the long-wave side of the resonance point O

The optical waves, which now experience infra-red dispersion, must clearly also be among the solutions In fact, both branches of the transverse solutions satisfy the relation

$$\frac{4\pi^2c^2}{\omega^2\lambda^2} = \varepsilon_\infty + \frac{\varepsilon_0 - \varepsilon_\infty}{1 - (\omega/\omega_0)^2},$$

which we recognize as the infra-red dispersion formula, hence all the transverse solutions must be none other than the optical waves The unexpected conclusion thus follows that a number of what would be considered as optical waves in crystal optics are identical with the transverse lattice vibrations in the theory of ionic crystals If the graph is turned through 90°, the relation to the familiar dispersion curve (for no damping) becomes obvious the region between the *usual* longitudinal and transverse lattice frequencies is the region of perfect reflexion in optical theory, and the transverse lattice waves are the optical waves immediately below the dispersion frequency ω_0

The mathematical considerations are given in a paper to be published shortly[7], where the nature of the energy density (that is, whether mechanical or radiative) for the solutions is also investigated

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[1] Thompson, J H C, *Proc Roy Soc*, A, **149**, 487 (1935)

[2] Kellermann, E W, *Phil Trans Roy Soc*, A, **238**, 513 (1940)

[3] Huang, K, E R A Report *L/T*239 (1950)

[4] Frohlich, H, and Mott, N F, *Proc Roy Soc*, A, **171**, 496 (1939)

[5] Lyddane, R H, and Herzfeld, K F, *Phys Rev*, **54**, 846 (1938)

[6] Lyddane, R H, Sachs, R G, and Teller, E, *Phys Rev*, **59**, 673 (1941)

[7] Huang, K, *Proc Roy Soc* (in the press)

Crystal Structure of Valentinite and Complex Antimony (III) Fluorides

IN connexion with a study of the stereochemistry of lead[1], some compounds of trivalent antimony were also discussed In this discussion it was erroneously stated that the structure of the orthorhombic modification of antimony trioxide, valentinite, is built up of finite molecules As is obvious also from the figure in that paper (Fig 4, p 15), Buerger and Hendricks's original description of the structure[2] with infinite double chains of the composition Sb_2O_3 is quite correct Unfortunately, in the new edition of Gmelins Handbuch[3], the structure is described as in my paper

In both the orthorhombic and the cubic modifications[4] of Sb_2O_3, there are three short Sb—O bonds of length 2 0 A, but also some longer Sb—O distances of 2 5–2 6 A in the orthorhombic form and 2 9 A in the cubic one, which may correspond to weaker secondary bonds In the structure of KSb_4F_{13} [5] four SbF_3 groups with Sb—F = 2 0 A are arranged around the thirteenth fluorine atom with F—4Sb = 3 0 A Further, between an antimony atom in one group and two fluorine atoms in another group, there are Sb—F distances of 3 0 A Thus the antimony atom is surrounded by six fluorine atoms, three at a distance of 2 0 A and three at 3 0 A, and a distorted octahedral arrangement is formed just as in the cubic modification[4] of Sb_2O_3

However, in the structure of $CsSb_2F_7$ [6], there i quite a different arrangement Here no SbF_3 group are found The antimony atom forms four bond with a mean Sb—F distance of 2 2 A Thus th Sb—F distances in the Sb—F—Sb bridge are o approximately the same length as the three othe Sb—F bonds In KSb_4F_{13}, in SbF_3 [7] and in the tw modifications of Sb_2O_3, it seems reasonable to assum that the three short antimony bonds are *p*-bonds However, the distorted tetrahedral arrangement in $CsSb_2F_7$ must evidently correspond to another typ of bond

ANDERS BYSTROM

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[1] Bystrom, A, *Arkiv Kemi Mineral Geol*, **25**, A, No 13 (1947)

[2] Buerger, M J, and Hendricks, S B, *Z Krist*, **98**, 1 (1938)

[3] Gmelin, "Antimon B2", 356 (1949)

[4] Almin, K E, and Westgren, A, *Arkiv Kemi Mineral Geol*, **15**, B No 22 (1942)

[5] Bystrom, A, and Wilhelmi, K-A, *Arkiv Kemi*, **3** (1950)

[6] To be published in *Arkiv Kemi*

[7] Bystrom, A, and Westgren, A, *Arkiv Kemi Mineral Geol*, **17**, B No 2 (1943)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, May 15

Society of Chemical Industry, Agriculture Group (at the Royal College of Science, Imperial Institute Road, London, S W 7), at 3 p m —Dr R L Edwards "Mushroom Composts and Mushroom Growing" *

University of London (at Bedford College for Women, Regent's Park, London, N W 1), at 5 15 p m —Dr V I Little "1851, Lecture 4, Astronomical Explorations" * (Further Lectures on May 17 and 22)

Wednesday, May 16

Chemical Council (at the Royal Institution, Albemarle Street, London, W 1), at 3 p m —Prof R P Linstead, F R S "Chemistry and the Amenities of Life" (Chemistry in the Service of Man, 1)

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m —Major-General G Cheetham "Map Production in Great Britain" (First lecture of a course on cartography for foreign students)

Royal Meteorological Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m —Sir Robert Watson-Watt, F R S "Meteorology and Aviation" (Presidential Address)

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof A Fessard (Collège de France) "Studies in Comparative Electrophysiology" * (Further Lectures on May 21 and 22)

Chemical Society (in the Chemistry Lecture Theatre, The University, Manchester), at 6 30 p m —Prof R B Woodward (Harvard) "Some Recent Advances in the Chemistry of Natural Products" (Centenary Lecture)

Oil and Colour Chemists' Association, London Section (at Manson House, 26 Portland Place, London, W 1), at 7 p m —Mr J T Richmond and Mr P E Watson "Some Applications of Electronics in the Pigment and related Industries" *

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London N W 1), at 8 15 p m —Dr O R Gurney "Ancient Cities in the Light of Archæological Discovery, 1, Boghazkoy" * (Further Lectures on May 23, 30, June 6, 13 and 20)

Thursday, May 17

Fauna Preservation Society (at the Zoological Society of London, Regent's Park, London, N W 8), at 4 15 p m —Dr F C Eloff "Wild Life Preservation in South Africa" (accompanied by a film)

London Mathematical Society (in the New Physics Building, The University, Manchester), at 5 p m —Dr K Mahler "P-adic Numbers and Diophantine Approximation"

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W C 2), at 5 p m —Prof I Schapera "Anthropology and the Social Sciences" (Inaugural Lecture) *

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 4 p m —Annual General Meeting, at 5 15 p m —Sir Lewis Fermor, F R S "The Mineral Deposits of Gondwanaland" (Presidential Address)

Physical Society, Acoustics Group (in the Physics Lecture Theatre, King's College, Strand, London, W C 2), at 5 30 p m —Dr G E Bennett and Dr H K P Neubert "The Measurement of Linear Vibration"

Society of Chemical Industry, Corrosion Group (at the Royal Institution, Albemarle Street, London, W 1), at 6 30 p m —Dr U R Evans, F R S "The Corrosion Situation—Past, Present and Future" (Inaugural Meeting)

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W 1), at 7 30 p m —Prof Brian Maegraith, Dr E Sherwood Jones and Dr W H H Andrews "Pathological Processes in Malaria—Progress Report"

Friday, May 18

Institution of Chemical Engineers (at the May Fair Hotel, Berkeley Street, London, W 1), at 11 a m —Twenty-ninth Annual Corporate Meeting, at 12 noon—Prof D M Newitt, F R S "Some Memorials of Early Chemical Engineers" (Presidential Address)

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Prof E G R Taylor "Early Charts and the Origin of the Compass Rose"

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof D Bovet (Rome) "Natural and Synthetic Sympatholytic Drugs, and their Structural Relationship with Sympathomimetic Substances" *

Royal Society of Medicine, Radiological Section (at 1 Wimpole Street, London, W 1), at 8 15 p m —Dr Ralston Paterson "Our Responsibility for Research" (Presidential Address)

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Sir Edward Salisbury, F R S "The West Australian Flora"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in Physiology—The Registrar, King's College, Newcastle-upon-Tyne (May 19)

Mathematician (Scientific Officer grade) with a good honours degree in mathematics or statistics, and an interest in biological problems and an **Assistant Experimental Officer**, with a degree in genetics, botany, agricultural botany or horticulture, in the A R C Unit of Biometrical Genetics, in the Department of Genetics, University of Birmingham—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S W 1 (May 19)

Lecturer or an **Assistant Lecturer in Biochemistry**—The Registrar, The University, Leeds 2 (May 21)

Lecturer in Mechanical Engineering, and a **Lecturer in the Department of Mining and Geology**—The Principal, Wigan and District Mining and Technical College, Wigan (May 22)

Mechanical Engineer—The Clerk to the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E C 1 (May 22)

Principal Scientific Officer or **Senior Scientific Officer** (with a first- or second-class honours degree in chemistry, and an interest in biological subjects) at the Ministry of Agriculture and Fisheries, Plant Pathology Laboratory, Harpenden—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting S/4025/51 (May 24)

Scientific Advisor (with a first- or second-class honours degree in mathematics or physics or mathematics and physics) in the Ordnance Survey Department at Chessington, Surrey—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting S 4022/51 (May 24)

Assistant in Biochemistry, for work in the metabolism laboratories at Stanmore—The Secretary, Institute of Orthopaedics, 234 Great Portland Street, London, W 1 (May 26)

Demonstrator in Psychology, to assist in the preparation of material, the supervision of practical work, and some tutorials—The Registrar, The University, Liverpool (May 26)

Scientific Officer (Chemist) for the Water Pollution Research Laboratory, Minworth, near Birmingham, for work on the effect of temperature on rate of oxidation of organic matter by bacterial action —The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 323/51A (May 26)

Chief Engineer or **Physicist** in the Engineering Research Division, Dominion Physical Laboratory, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W C 2 (May 28)

Assistant (with qualifications in either inorganic or physical chemistry) **in the Department of Chemistry**—The Secretary, The University, St Andrews (May 31)

I C I Research Fellowships in Chemistry or **Physics**, or some allied subject such as **Biochemistry, Chemotherapy, Pharmacology, Metallurgy** or **Engineering**—The Registrar, The University, Liverpool (May 31)

Lecturer (Grade II), or **Assistant Lecturer, in Botany**, a **Lecturer** (Grade II), or **Assistant Lecturer, in Zoology**, and an **Assistant Lecturer in Physics**, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (May 31)

Lecturer (temporary) **in Philosophy** at Canberra University College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 31)

Organic Chemist (with Ph D degree or equivalent research experience) as Research Assistant to the Professor of Medical Chemistry (at 183 Euston Road, London, N W 1)—The Administrative Officer in the United Kingdom, Australian National University, 27 Russell Square, London, W C 1 (June 1)

Scholarship tenable in the Cosmic Ray Section of the School of Cosmic Physics—The Registrar, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin (June 1)

Lecturer in Industrial Administration—The Registrar, College of Technology, Manchester 1 (June 2)

Lecturer in Mechanical Engineering—The Registrar, The University, Sheffield (June 2)

Junior Scientist at the Coal Survey laboratories at Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, endorsed TT/319 (June 5)

Research Assistant and Demonstrator (temporary) **in Botany** —The Registrar, University College, Cathays Park, Cardiff (June 5)

Scientific Technologist (with a good general training in chemistry, preferably up to Degree standard) at the Coal Survey laboratories at Chester—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, endorsed TT/320 (June 5)

Assistant Lecturer in Anthropology—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W C 2 (June 7)

Electronic Engineers in a Government Department (experience of development work, including circuit design in telecommunications, and of pulse techniques, an advantage)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 85/51A (June 14)

Lecturer in Physics at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (June 15)

Assistant (part-time) **in Speech Training**—The Registrar, The University, Manchester 13 (June 30)

Assistant Lecturer in Physics—The Dean of the Medical School, Guy's Hospital, London, S E 1 (June 30)

Aeronautical and **Mechanical Engineers** (Experimental Officer grade) at Ministry of Supply research and development establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 679/50A

Biochemist in the Department of Preventive Dentistry—The Secretary, Eastman Dental Hospital and Institute of Dental Surgery, Gray's Inn Road, London, W C 1

Civil Engineers, to be responsible for the design, development layout and construction of ancillary buildings for large chemical factories, including roads, railways, water pumping plants, distribution mains and drainage, sewage and allied civil engineering works—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

DESIGN ENGINEERS (Civil), and ENGINEERS (Civil, Grades 5, 4, and 3), in the Civil Engineering Branch, Design and Construction Department of the State Electricity Commission of Victoria Melbourne—The State Electricity Commission of Victoria, 2nd Floor, 475 Oxford Street, London, W 1

ENTOMOLOGIST at the Society's Gardens, Wisley, Surrey—The Secretary, Royal Horticultural Society, Vincent Square, London, S W 1, endorsed 'Confidential'

GRADUATE IN CHEMISTRY to assist in the biochemical investigation of the action of A C T H and cortisone in rheumatic fever—The Administrative Officer, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks

GRADUATES IN PHYSICS or ENGINEERING for junior research positions with the National Research Council, Ottawa, to work in one of the following fields vacuum tube research, radar development, dielectric research, electronics and antenna design—The National Research Council of Canada, Africa House, Kingsway, London, W C 2

HEAD (Principal Scientific Officer grade, with an honours degree in mechanical engineering or metallurgy, and experience of research in mechanical or production engineering and metallurgy very desirable) of a new organization planned for co operative research in the Cutlery industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1 endorsed 'Cutlery'

MECHANICAL ENGINEER, to design and instal various types of mechanical plant, including machine tools, pumps, cranes and compressed air plant for large factories and to investigate maintenance problems—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

PHYSICIST (preferably of Ph D standing) to work in collaboration with an engineer on the development of new machinery—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Methods of Test for Textiles PD 1096, Addendum No 1, 1950 to B S Handbook No 11, 1949 edition Pp 11 (London British Standards Institution, 1950) 1*s* net [181

Annual Report and Transactions of the Yorkshire Philosophical Society for the Year 1949–50 Pp 20 (York Yorkshire Museum, 1950) [181

University of Cambridge Report of the Observatories Syndicate for the Year ending 1950 September 30 Pp 4 (Cambridge The Observatory, 1950) [181

Ministry of Agriculture and Fisheries Fishery Investigations, Series 1, Vol 5, No 2 Salmon Studies By Dr J W Jones Pp 23 (London H M Stationery Office, 1950) 1*s* 6*d* net [181

Film Centre Educational Pamphlets, No 5 Film Discussion Groups in Fundamental Education By Peter Brinson Pp ii+21 (London Olen Press, 1950) 1*s* [181

County Borough of Doncaster Art Gallery and Museum Annual Report, 1949–1950 Pp 14 (Doncaster Art Gallery and Museum, 1950) [181

Year Book of the Textile Institute No 3, 1950–51 Pp xxii+246 (Manchester Textile Institute, 1950) 10*s* [181

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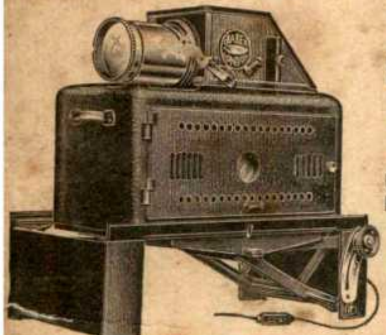

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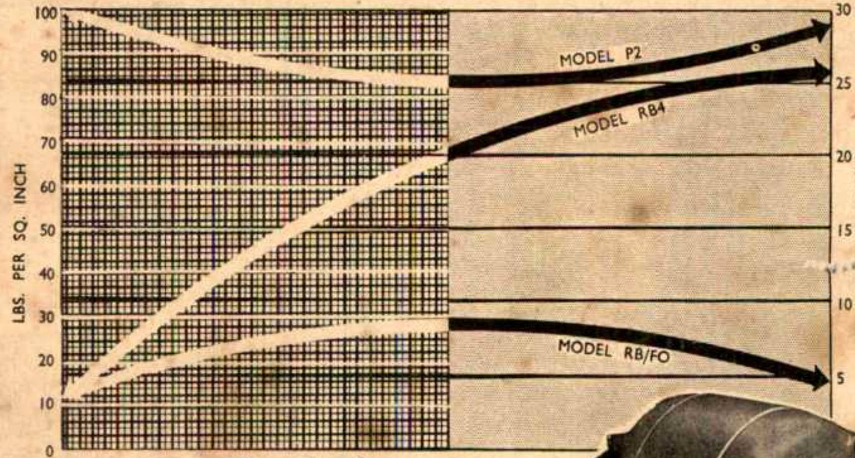

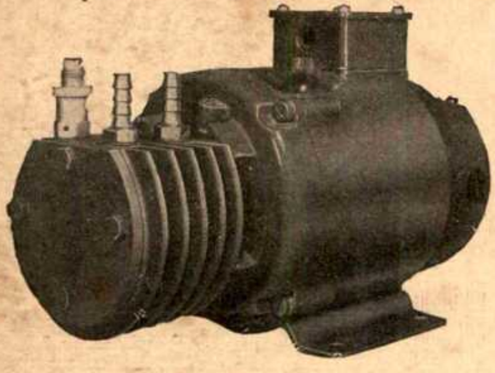

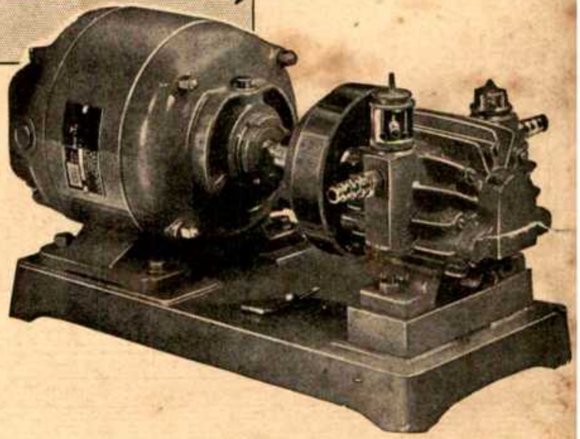

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SCIENCE AND THE MACHINERY OF GOVERNMENT

A RECENT study of democracy by the warden of Nuffield College, Mr Alexander Loveday, published under the title "The Only Way"*, well illustrates the point that the proper concern of the scientific man or other professional worker for the conditions under which he can most effectively pursue his occupation and maintain the highest standards and traditions makes it impossible for him, collectively or individually, to be indifferent to the political conditions or climate in which he works The issues involved may be such as to affect directly the maintenance of professional standards of conduct or the advancement of science, and there would be dereliction of public duty if those concerned, either through their professional associations or as individuals, did not explain the situation to the public and suggest remedies

Clearly there will always be room for differences of opinion as to where to make a stand One reflexion suggested by Mr Loveday's study of the dangers affecting democracy is that those men of science who have been seriously concerned with the effect on their science of the political conditions under which they pursue their work have substantial justification for their fears about possible adverse effects to-day Conditions detrimental to political freedom, including freedom of communication and movement generally, are rarely anything but detrimental to the atmosphere in which science and other creative activities flourish

A second reflexion suggested by this same book is that the steady erosion during the past few decades of the ideals and standards of democracy has reached a point when the preservation of science itself requires men of science to join in resisting that process To Mr Loveday, democracy is something more than a mode of government, it implies a way of life, a body of doctrine which determines that way, and the faith which inspires that doctrine He is more concerned with democratic societies than governments, and with social values and conceptions of welfare than with constitutions, and while he admits that in no society is there a rigid order of values, he points out that many of the most important democratic ideals find their clearest expression in the rules of conduct which constitute our ethical system Four principles, he suggests, have guided democracies in their attempt to find a solution to the problems of individual freedom and self-realization the individual is himself the best judge and the best exponent of his own capacities, the criteria for expression and development are seen in the degree of internal harmony finally achieved, likewise, actions which disturb social harmony should be avoided, and those which promote social harmony, or are required to protect society, should be carried out

These second and third principles are intermeshed, because man is a social being Moreover, Mr Loveday maintains that man is more than a material object; materialism, he believes, is the antithesis of democracy, and Mr Loveday's fourth principle is that, to the extent that science can assist man to determine his individual and collective capacities, it should be used and its findings put at the disposal of the individual to aid him in making his own choice It will be apparent already that Mr Loveday's views as to the contribution of science, and particularly the functions of planning, are restrained, but the limitations are not so much inherent in science or in the technique of planning as in the capacity of those by whom they are used or the individuals for whose benefit they are applied

---

* The Only Way By A Loveday Pp xvi+221 (London W Hodge and Co , Ltd , 1950) 12*s* 6*d*

The most arresting feature of this book is indeed its exposition of the faults of social and economic planning in general, and its demonstration that the difficulties arise when the necessary understanding and co-operation are not forthcoming in the community It is then, when the element of compulsion comes in, that democratic ideals and values are endangered, because without public response and understanding it is impossible for the objectives of the planners to be secured at any stage short of a totalitarian regime, which is the negation of democracy The danger to democracy arises, in fact, not from the technique of planning as such, but when groups and individuals in the community ignore their duties and responsibilities to that community, and fail to exercise that self-control and discipline which a democracy implicitly demands If the requisite effort is not forthcoming from the community, planning at once launches us on the slippery road to full totalitarianism

Prof R M MacIver wrote recently in "The Ramparts We Guard"* "The assumption of democracy is that the sense of the public interest will move the majority of the public and that it will on the whole over-ride the encroachments and aggressions of particular private interests If this assumption should prove false, democracy must, in the long run, break down Democracy cannot long co-exist with group anarchy" Mr Loveday puts the same truth in other words, which point even more clearly to dangers inherent in certain events since both books were written "The gravest threat to individual liberty, however, arises not when there is a failure by some group or even by the whole community to perform some social function expected of it, but when any group causes inflation by endeavouring to secure for itself too great a share of the national resources"

Mr Loveday's book is more than a realistic discussion of the nature of freedom and of the way in which physical rights are the prerequisite of all others It gives also an objective review of post-war policy in Great Britain which shows clearly the extent to which democratic ideals and traditions are already endangered by forms of economic control which are the very antithesis of the social system and the ethic for which democracy stands The antithesis arises, indeed, not from control as such but from the extension of control to a point at which the degree imposed threatens the scope for personal development and the internal harmony of the individual, or at which some other objective than the attainment of that development and harmony is accepted as the purpose of government

The central thesis of this book is that the harmony of the democratic society in which we live depends on the respect paid by individual citizens to the ethical principles on which it is based That those principles have been disregarded on occasions, both in government policy and in the actions of certain groups in the community, is a matter of wide concern. Mr Loveday does not provide facile answers, but some of the major issues are clearly displayed, and indications are given of ways in which the dangers may be diminished In some of these, men of science may perhaps contribute directly They may be able to help individually and professionally in the transmission of the democratic ethic and especially of the principle of toleration They could, at least by example, combat the tendency to excessive submission to authority, and help to encourage the growth of alert and responsible public opinion, prompt to detect and expose abuse of power By training and tradition they are qualified to set an example of the moderation in demands and in behaviour which the preservation of liberty requires

Mr Loveday's study is concerned essentially with the social aspects of a democratic society and the way in which they impinge on the conduct and ideals of its constituent groups, recent pamphlets on the nationalized industries now being issued by the Acton Society Trust (see *Nature*, April 14, p 595) show how the structure of government is also involved Democracy is threatened not only by the immoderate demands of constituent groups, who ignore or repudiate the values and ideals on which it is based it can also be endangered by forms of organizatio which are ill-adapted to the purposes they are intended to serve

That much is brought out particularly in the Acton pamphlets on accountability to Parliament and on problems of promotion policy, both of which insis on the need for impartial but searching examination of the problems Insistence on the need for such scientific and impartial investigation is one of the features common not only to Mr Loveday's book and these pamphlets but also to the study of "British Government since 1918"*, instigated by the Institute of Public Administration Mr. Loveday looks to the universities, for example, to play a leading par in the analysis and interpretation of the principle of democracy, and particularly in the deeper study and wider teaching of democratic values which ar necessary to avert the present threat The con sequent public understanding is as important a moderation both in demands and in behaviour i democracy is to survive In "British Governmen since 1918". the same note is struck by severa contributors Prof W J M Mackenzie's review o the structure of central administration, which includes a penetrating criticism of the Haldane Report on the machinery of government bearing closely on the issues raised in the recent re-allocation of responsibilities between the Ministry of Health and the Ministry of Local Government and Planning, stresses in this very connexion that the first essential for reform is public and professional interest and understanding, until these are stirred, it is useless to think that anything substantial can be achieved by reorganization at the centre Similarly, in his survey of administrative law in England, 1919–48—much the largest study in the book—Prof W A Robson not only brings out the implications for personal freedom and justice of some of the developments, such as the increasing practice of delegating legislative powers to the executive, but also the importance both of Parliament taking a serious and continuing interest in the subject and of the quality and quantity of public law teaching and research in the universities

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* "The Ramparts We Guard" By Prof R M MacIver (New York and London Macmillan and Co, Ltd, 1950) 22s 6d

* British Government since 1918 By Sir Gilbert Campion, D N Chester, Prof W J M Mackenzie, Prof William A Robson, S Arthur Street and J H Warren. Pp 232 (London George Alle and Unwin, Ltd., 1950) 16s net

There is in truth some overlapping and repetition in these studies, and the treatment of the themes is not always in proportion Nevertheless, although the book scarcely contains, as Sir John Anderson suggests, all the information which a student or general reader may require on the subject, it indicates both the need for impartial study of the whole structure of government and also very precisely some of the weaknesses of the present system and the points at which constructive thought is required

One thing that emerges is the extent to which the real problems are independent of party politics, but are likely to require the combined effort of open minds of all parties to work out effective solutions and secure their adoption To the man of science, Prof Mackenzie's paper is one of the most interesting, not simply because it reminds us that academic freedom at present depends in part on inefficiency in the machinery of government, or because it discusses the organization of research in the light of the Haldane Committee's advocacy of a central department of research, but rather for its insistence that the problem is a practical one and not purely theoretical In fact, Prof Mackenzie's conclusion is all against reorganization beyond the very minimum, and he believes that the less dislocation the Departments of State suffer at present the better

So far as reform is concerned, the major issue raised in the book is that of local government Both Prof Robson and Mr J H Warren firmly challenge the Government's abolition of the Local Government Boundary Commission, and their essays lend strong support to Sir Malcolm Trustram Eve's plea, in a lecture given in the University of London on February 6, for reform of the structure of local government Both make it evident that reform alone can arrest and reverse the decline in a political institution which was never more needed than to-day to preserve the vitality of democracy, and to give individuals a means of expression and interest to offset the tendencies which make so much of the organization of government not merely complex and immense but also remote and impersonal

It is true that, as Mr. Warren points out, political principle must always be conditioned by administrative considerations, and that the particular sphere to be assigned to local self-government is not a question which can be determined wholly by considerations of democratic responsibility, viewed as capable of development by ties of neighbourhood and the activity of local communities, or even by the consideration that local self-government is an educative process and invaluable to democracy on that account alone To admit that some regard must be had to administrative consideration in assigning local government functions is not to allow, however, that such considerations should be the sole or even the decisive factor Moreover, as Prof Mackenzie remarks, while the Haldane principle, of allotting functions by services to be rendered rather than by clients to be served, is the most economical way in which to use a limited staff of experts, it is not necessarily the most economical for the public.

The Haldane principle was formulated in respect of government departments, but there and in local government it may sometimes be wise and indeed necessary to break it on other considerations Certainly, the recent changes in ministerial responsibilities should be considered from other points of view Even if it is reasonable in theory for the new Ministry of Local Government and Planning to take in the whole range of public housing, planning and the control of the use of land, it does not follow that it is reasonable practice The Ministry of Town and Country Planning has hitherto given little evidence that it has the standing required to enable it to adjudicate with authority between the demands of defence, industry, agriculture and amenity, and to provide a national plan rather than a series of local truces, nor does the new Ministry possess any local government tradition There are likewise reasons for holding that the functions of the Ministry of Health have now become too restricted, and that its responsibilities should extend to those environmental services like water and sewerage, sewage disposal, street cleansing and similar matters, in which public health is the dominant consideration

There is plainly room for some clear thinking on points such as these, and the basis should not be adherence rigidly to some theoretical principle of distribution of functions, but consideration of the practical issues and, above all, of the public to be served It is because of this that the matter is one which deserves attention, not simply by the administrative expert but also by professional men, many of whom have to man the services concerned, and by the ordinary citizen. Whether or not housing would better have been placed with the Ministry of Works, it is vitally important that the new Ministry of Local Government and Planning should be as neutral as possible as well as authoritative in co-ordinating the claims on resources put forward by various government departments Success in that field, however, will never compensate for failure to deal as a matter of urgency with the question of local government reform There the recommendations of the Boundary Commission, based on an exhaustive survey, have narrowed the range of disinterested argument to limits within which a broadly satisfactory solution could be reached if the Government would give a lead Nor is it a matter which is a party issue It will augur ill for the future of democracy if, even in the present circumstances, the Government refuses the opportunity of effecting a reform which could bring new life and interest just where it is most needed to give real meaning to democracy and freedom Once local government and local democracy become ineffective, other groups, such as the professional associations, are unlikely to find that they can for long provide the means for the individual to contribute effectively to the great task of government, or that the atmosphere of freedom in which they thrive and do their most creative work will long survive

PHYSIOLOGICAL FOUNDATIONS OF MYCOLOGY

Physiology of Fungi

By Dr Lilian E Hawker Pp xvi+360+5 plates (London University of London Press, Ltd , 1950) 21*s* net

WITHIN every problem of fungal ecology is embedded a problem of fungal physiology. Mycologists have become diverse and specialized in their particular interests, but none can afford to neglect the unifying discipline of physiology It seems all the more remarkable that, until recently, no text-book of general fungal physiology was available, nor had anyone produced even a comprehensive modern review article to fill this gap In 1947, F A. Wolf and F T. Wolf made a courageous attempt to supply this need in the second volume of their text-book "The Fungi" Ranging widely over the fields of fungal physiology, biochemistry and ecology, these authors were unable to do full justice to the great volume of work published on fungal physiology alone Jackson W Foster's "Chemical Activities of Fungi", published in 1949, is exceedingly comprehensive within the restricted scope defined by its title, but many aspects of fungal physiology have been deliberately excluded from consideration by this author It has thus been left to Dr L E Hawker to produce the first truly comprehensive work on the physiology of fungi, and she has rendered thereby a signal service to all mycologists

This book owes not a little to the environment that has nurtured it. the Department of Botany at the Imperial College of Science and Technology, London, as Dr Hawker has indeed acknowledged in the tribute she pays to Prof William Brown in her preface As a fungal physiologist and pioneer investigator of the physiology of parasitism, with which his name will always be specially associated, William Brown occupies a unique position, in the acknowledgment of which Dr Hawker has placed in her debt a host of Prof Brown's former research students, for many of whom this association has been deeply significant for their subsequent output It will always be regretted that Prof Brown did not find time to write such a book himself, but let it be said at once that upon none of his former associates could the cloak of Elijah have descended more fittingly than upon Dr Hawker, who is well known for her own distinguished researches on fungal physiology, particularly with respect to growth factors and carbohydrate metabolism

Although biochemists have become increasingly interested in the physiology of fungi and other micro-organisms, as much as ever yet awaits investigation in the field of gross fungal physiology, which still remains the proper sphere of the mycologist as such As Prof Brown remarks in his foreword to this book "In the last resort, the greatest scientific interest concerned lies in the functioning of the organism as a whole" This book presents, in fact, a study of the whole fungus in relation to the whole of its environment, and it comprises a body of knowledge which is essential for any mycologist who has to manage fungi as living organisms The comprehensive scope of this work is indicated by the chapter headings following upon the introduction come chapters on growth and variation, nutrition, respiration and fermentation, effect of nutrition on sporulation, other environmental factors affecting growth and reproduction, survival and germination of spores, and interaction, including parasitism, with other organisms

Such criticisms as can be made relate chiefly to errors of omission, which may be ascribed in part to a prolonged gestation in press Aeration of culture solutions and the shake culture technique, which have been exhaustively discussed by Foster, are barely mentioned here It seems unduly conservative to dismiss these new techniques, together with the perfusion technique, as not "practicable on a large scale in the average laboratory" (p 21) The replacement culture method for dissimilation studies is not mentioned

Apart from such relatively minor gaps, this book has been admirably planned and executed, and is singularly free from typographical and trivial errors It is not easy to produce a standard work of reference, it is still more difficult to reduce such a mass of data as Dr Hawker has had to handle to a text that can be read straight through without effort This second objective, unperceived, rejected or abandoned in despair by more prolific writers, has also been achieved by Dr Hawker, and this is not the least part of her success in the production of a very useful and timely book S D GARRETT

SPACE-TIME STRUCTURE

Space-Time Structure

By Erwin Schrodinger Pp viii+119 (Cambridge At the University Press, 1950) 12*s* 6*d* net

SCHRÖDINGER shares with Einstein the belief that there must be a natural generalization of the relativistic theory of gravitation which could serve as a secure base for dealing with all other natural phenomena electro-magnetism meson fields and their interactions Einstein himself has given a short account of his ideas in a little book, "The Meaning of Relativity", which I have reviewed in *Nature* (166, 751, 1950) In fact, the two books by Einstein and Schrodinger have a common background of conviction and method, their aim is the same But otherwise they differ thoroughly Einstein's book discusses the idea of a unified theory only in a brief and condensed appendix, while the main text (a revised version of his Stafford Little Lectures of 1921, published 1922) is a rather elementary account of special and general relativity which can be recommended to students as an introduction to the subject Schrodinger's new book is an attempt to prepare the reader right from the beginning for the generalized unitary theory This is achieved by an extremely careful, and at the same time most elegant, development of tensor calculus in three stages, corresponding to the Parts 1, 2 and 3 of the book the unconnected manifold, the affinely connected manifold and the metrically connected manifold The mathematical foundations given in these chapters are a masterly work of art, a pleasure to read for a scholar or a well-trained student, but scarcely useful as an introduction for a beginner Right from the first appearance of the affine connexion it is made clear that no stringent reason can be given for assuming the affinity to be symmetric The symmetric case is then discussed as an example which Einstein selected, because of its simplicity, for his original theory of gravitation But the possibility of dropping this restriction is always kept in mind

The main difficulty in the general theory is the proof that the field equations obtained by generalization from Einstein's gravitational equations are compatible Schrodinger overcomes this difficulty by deriving the field equations from a variational principle , in this way the equality of the number of independent equations and of the number of unknown functions is automatically guaranteed The central feature of these considerations is the fact that the conservation laws in general relativity are not valid as consequences of the field equations but are identities due to the invariance of the variational integral The virtuosity displayed by Schrodinger in disentangling these complicated relations in such a way that they look quite simple and obvious makes the reading of the two last chapters of the book a particular delight He shows that there is essentially only one reasonable generalization of Einstein's theory of gravitation obtained by dropping the symmetry of the affine and metric connexions, namely, that given by Einstein and Strauss But he adds a new version of his own where, to begin with, only an affine connexion is postulated, while the metric is derived from it, and it is interesting that the equations obtained in this way are slightly more general they reduce in the symmetric case to Einstein's equation with cosmological term Schrodinger says "The purely affine theory is the only one that produces this term in a natural, non-premeditated way".

The main aim of the book is certainly this demonstration that the way originally opened by Einstein leads uniquely to this theory, that no other possibilities exist The logical argument has been brought to perfection, and its effect is even enhanced by the fact that Einstein and Schrodinger have independently reached the same result No deviation from the straight path of reasoning is permitted, not even an illustration by one of the important applications of Einstein's theory of gravitation, things to be found in ordinary books on relativity But if the reader expects to find some outlook on more familiar ground from the summit he is disappointed The discussion of the results given in the last, very short section reveals that no special solution of the new field equations has yet been found which might suggest an application of physical interest, say the representation of particles by fields with point singularities Not even a clear-cut separation of the various fields (gravitation represented by the symmetric part, electromagnetism by the skew part of the metric tensor) can be given, and one must be prepared to accept that none exists. In spite of this, Schrodinger declares "that the difficulty of finding exact solutions should not deter us from thinking further about these theories", because they are to his mind "the only natural generalisations of an eminently successful predecessor" Schrodinger, however, differs from Einstein in so far as he is strongly aware of the power and success of quantum mechanics Therefore he does not, like Einstein, expect progress from complicated "particle solutions", but indicates that a study of plane sinoidal waves, as used in quantum mechanics, may be a reasonable, though not ideal approach

This stimulating book can be recommended to all those who enjoy the intellectual pleasure of perfect logical penetration and condensed presentation of a theoretical structure derived from simple assumption, without demanding tangible results MAX BORN

LIGHTNING

The Flight of Thunderbolts

By B F J Schonland Pp viii+152+6 plates (Oxford Clarendon Press , London Oxford University Press, 1950) 15*s* net.

KNOWLEDGE of the mechanism of growth of lightning discharges has greatly advanced during recent years, largely as the result of the research carried out in South Africa by Dr B F J Schonland and his colleagues While it had been known previously that a single lightning discharge generally consists of a number of separate strokes, which occur successively at short time-intervals along the same path, the direction of growth of the individual strokes was a matter of conjecture until 1933 In that year Dr Schonland initiated a series of investigations in which lightning discharges were photographed by a rotating-lens camera of the form suggested by Sir Charles Boys The results showed that the separate strokes could each be resolved into two components which are now known as the leader stroke and the return stroke The former grows down from the cloud to ground to form an ionized track along which the return stroke, carrying the main current of the discharge, afterwards occurs The characteristics of these luminous processes has been studied in great detail by Dr Schonland and his colleagues The associated electrical effects, as evinced in radio atmospherics, have also been recorded in later experiments and have been correlated with the visual growth of the discharge

Dr Schonland's experiments have provided a great stimulus to other research workers engaged in studies of lightning discharges, and his results have been confirmed and extended by investigators in other countries Research on spark discharges has also been stimulated, and within a few years of the initial experiments on lightning the same sequence of leader and main stroke was observed to occur in sparks in the laboratory

As a consequence of his very wide experience and knowledge of lightning phenomena, Dr Schonland is eminently qualified to write on this subject, and his book will be welcomed by all who are interested in atmospheric electricity The first two chapters give an entertaining account of early views and superstitions concerning lightning and of the historical development of lightning rods The various forms taken by lightning and some of its effects are discussed in Chapter 3, which is followed by two chapters dealing mainly with Dr Schonland's own experiments on the luminous processes and the electrical characteristics of lightning discharges Chapters 6 and 7 deal respectively with the methods of protection against lightning and the mechanisms of electrification of thunderclouds In the final chapter, radio atmospherics, and their utilization for the location of thunderstorms by direction-finding methods, are discussed

The book is clearly intended primarily to appeal to the general reader and is most successful in this respect From the point of view of the specialist, however, it has the defect that the treatment is descriptive only and that few references are given to the published sources of the experimental work described Nevertheless, it will be read and enjoyed by all specialists who like to have an elementary but authoritative account of the subject

There is as yet no comprehensive book dealing with the physics of lightning discharges to which the research worker in the field, whether physicist, meteorologist or electrical engineer, can refer It is to be hoped that the present book will prove to be the precursor of a research monograph on lightning by Dr Schonland in which the admirable lucidity of the present volume will be combined with a deeper treatment of the subject J M Meek

UNIVERSITIES OF THE BRITISH COMMONWEALTH

The Yearbook of the Universities of the Commonwealth, 1951

(Published for the Association of Universities of the British Commonwealth) Pp xxxi+1416 (London G Bell and Sons, Ltd , 1951)

It is approximately a year since the previous edition of this "Yearbook" was published, and, as stated in the preface of the present volume, the aim is to issue future editions in the first quarter of each year The book is published by the Association of Universities of the British Commonwealth and records details for all university institutions of the Commonwealth and not merely member institutions of the Association

Besides the usual information on the lines of former issues, there are reports of events of outstanding interest which have occurred since the compilation of the previous edition Thus the present publication records the inauguration of the University College of North Staffordshire and of the New South Wales University of Technology, Memorial University College, St John's, has become the Memorial University of Newfoundland, and the University College of the Orange Free State has also been elevated to university status For the first time, entries have been made for the Canadian institutions of Mount St Vincent College, St Dunstan's College, St Joseph's College and Sir George Williams College, for the Indian Universities of Jammu and Kashmir, and Poona, and a full entry for the University of Malaya As a result of the separation of the Republic of Ireland from the Commonwealth in 1949, the entries for the Universities of Eire have been placed in an appendix A further alteration has resulted by the advent of the new General Certificate of Education, and Appendix 1, which deals with the matriculation requirements for United Kingdom universities, has been accordingly amended

Of the main contents of the book, suffice it to say that there are the usual compilations relating to staff (approximately 28,000 names), general information, new events, introductory chapters on the history, regulations and practices of the universities in the different countries, and appendixes, dealing with a variety of subjects such as post-graduate awards tenable in the United Kingdom (which is also available as a separate pamphlet) and overseas, statistics on overseas students in the United Kingdom, the Inter-University Council for Higher Education in the Colonies, and information for those intending to study in the United States An index of names and a general index round off the work

Little further need be added about this excellent publication, except perhaps the rather obvious remark that for a volume of its size it contains an extraordinarily large amount of useful information

EARTH WAVES

Earth Waves

By Prof L Don Leet (Harvard Monographs in Applied Science, No 2) Pp v+122 (Cambridge, Mass Harvard University Press, New York John Wiley and Sons, Inc. London Chapman and Hall, Ltd , 1950) 24s net

Much of the material of this instructive little book was collected by Prof L Don Leet for presentation as a course of eight lectures on the "Applications of Seismological Techniques to Engineering Problems" for the Lowell Institute of Boston He has had wide experience in the use of the seismic method in prospecting for oil and bauxite, and has made a special study of the earth motion resulting from the atomic bomb test in New Mexico in 1945 Prof Leet, who is professor of geology in Harvard University and seismologist in charge of Harvard Seismograph Station, has developed a three-component portable seismograph

This book is a model of clarity, and, although first-year university standard in mathematics and physics is assumed, the reader need not have any prior knowledge of either geology or seismology The book is well illustrated with line diagrams of apparatus, graphs, terrestrial sections and seismograms It is divided into four chapters The first deals largely with forced vibrations and the theory of the seismograph The second chapter discusses the major types of waves observed in seismology, and it is to be noted that the symbols used for elastic constants are in accordance with the American Standards Publication *ASAZ* 10 6–1948 (American Society of Mechanical Engineers, New York, 1948) Some of these symbols differ from those in current use in the literature of seismology, though there need be no confusion since Prof Leet is careful to list and explain all symbols used Chapter 3 deals with the effect on earth waves of various earth structures commonly met with, and the consequent variation in seismograms The final chapter treats of microseisms and the use of the tripartite seismograph installation to track storms at sea

The whole work is a most valuable bridge between theoretical and practical seismology Full references are given, there is an adequate index, and the printing and format leave little to be desired

Ernest Tillotson

Réactions dans l'état solide

Colloques Internationaux du Centre National de la Recherche scientifique, 10 Pp iv+222. (Paris Centre National de la Recherche scientifique, 1950) 1,100 francs

DURING recent years there has been a welcome revival of the pre-war practice of holding international colloquia on scientific subjects, and, with the financial assistance of the Rockefeller Foundation, the Centre National de la Recherche scientifique has been particularly active in this direction Under the auspices of that body one of the colloquia held during 1948 was on reactions in the solid state , it took place in Paris during October 1–6 and was attended by many distinguished chemists and physicists of various nationalities These included Profs G Borelius and A J Hedvall (Sweden), Dr E J W Verwey (Netherlands) and Drs P W Selwood and K J Laidler (United States) From Great Britain there were Dr G W Brindley (Leeds), Prof N F Mott and Prof W E Garner, Drs T J Gray and J W Mitchell (Bristol), Dr R M Barrer (London) and Dr D M C MacEwan (Rothamsted) Belgium, France, Italy, Norway and Switzerland were also represented

The proceedings of the colloquium have now been published The volume consists of the text, in French, of the forty-odd papers and notes presented, together with a preface specially written by Profs G Chaudron and J Bénard, the able organizers of the colloquium, and is a reprint of the January/February and March/April 1949 issues of the *Bulletin de la Société chimique de France* Each paper is provided with a synopsis

The concluding paper in the volume is by Prof A. J. Hedvall, who was one of the pioneers in the study of reactions in the solid state and whose book "Reactionsfähigkeit fester Stoffe", published in 1938, is an authoritative work on the subject In summing up the conclusions of the various other papers, Prof Hedvall directs particular attention to the results obtained by magnetic methods such as those on the reactions of solids at transformation temperatures He cites various examples of present technical applications of the chemistry of the solid state in the glass, ceramic and concrete industries and in powder metallurgy, and describes some of the research problems being undertaken in his own laboratory

S W

Rocky Mountain Naturalists

By Joseph Ewan Pp xv+358+9 plates (Denver, Colo University of Denver Press, 1950) 5 dollars

JOSEPH EWAN'S book falls into two parts The first contains biographies of nine leading naturalists of the Rocky Mountain area, and the second a list, set out in dictionary form, of natural history collectors in the area Among the biographies is one of Edwin James, the first botanist to visit Colorado to make a systematic collection of plants , John Charles Fremont, the general and botanist who stood as a candidate for the presidency , Charles Christopher Parry, the medical man who named so many Colorado mountains , Harry Norton Patterson, the Oquawka printer and botanist who did much collecting in the Gore Range area , Marcus Eugene Jones, the Iowa teacher of Latin who became an explorer and for more than sixty years travelled in search of rare plants , Edward Lee Greene, the Episcopalian rector of Georgetown, Colorado, who besides becoming well known as a writer, is also remembered for his tenacity in advocating the "fixity of species" against all Darwinian protagonists , Thomas Conrad Porter, professor of natural history at Lafayette College, who simultaneously acted as pastor of a Reformed Church and translator of Germanic literature , Eugene Penard, the Swiss protozoologist who compared the Rocky Mountain lakes with those of the Alps , and, finally, Prof Theodore Dru Alison Cockerell, the friend of Alfred Russel Wallace who, though possessing no academic qualifications, came to be recognized as an authority on fish scales and bees

This remarkable book is well written and should serve as a useful companion to Prof S W Geiser's "Naturalists of the Frontier", with its accounts of distinguished naturalists of Texas and the Southwest

Fundamentals of Organic Chemistry

A Brief Course for Students concerned with Biology, Medicine, Agriculture and Industry By James Bryant Conant and Prof Albert Harold Blatt Pp ix+413 (New York The Macmillan Company , London Macmillan and Co , Ltd , 1950) 30*s* net

THIS book differs from most elementary works on organic chemistry by beginning with alcohol and taking up hydrocarbons in the third chapter The aliphatic substances are dealt with separately from the aromatic The biochemical aspect is emphasized, in view of the type of reader contemplated, and the text is modern Electronic theories are explained and used in the appropriate places Quite complicated compounds, such as cholesterol, vitamins, porphyrins, and hormones find their place The scope is not sufficient for degree students, but for medical students and those beginning organic chemistry the book should be attractive and stimulating Some of the theoretical sections should interest more advanced students

Atlas of Drawings of Chordate Anatomy

By Prof Samuel Eddy Pp xi+150 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949) 28*s* net

THE American professor of zoology who has to deal with very large classes is driven to adopt any device that will save time and eliminate drudgery To this end Prof S Eddy, with the help of Mrs Louise Bush, has prepared 189 unlabelled drawings illustrating the morphology of the chief chordate types By using these he claims that the student sees more, gets a general idea beforehand of what he should find in his dissections, and has a more clearly defined visual picture afterwards than his own laboured and often inaccurate drawings would have given him Many British zoologists would disagree with him, for in Great Britain the hard way is preferred, which compels the student to observe before committing his ideas to paper, and trains his visual memory, so much more difficult to develop than the verbal memory

The types employed in this work are *Amphioxus*, *Molgula*, the Ammocœte larva, dogfish shark, a teleost, *Necturus*, the alligator, tortoise, pigeon and cat The outline drawings are on the whole excellent, and are sufficiently generalized to allow of additions and modifications There are a few errors, as in the alligator skull (90), and the cat (venous system 151*A*), and it is somewhat confusing to find arteries sometimes white and sometimes black Also, the description of the figures might be correlated better Perforations allow of the rearrangement of the pages

BRITAIN'S SCIENTIFIC SHRINES (2)

By Eng.-Captain EDGAR C SMITH, O.B.E, R N

THE SOUTHERN COUNTIES

OF all the counties of England none is richer in scientific associations than Kent From Greenwich, with its Royal Observatory, its Royal Naval College and its National Maritime Museum, to Folkestone, in the gardens of which stands the bronze statue of William Harvey, the countryside is full of places of interest A 'Mecca' for the visiting astronomer, the Royal Greenwich Observatory—much of the work of which is being transferred to Herstmonceux, in Sussex—has many historic instruments preserved in Flamsteed House, built by Wren in 1675 Here have laboured the ten Astronomers Royal carrying out those fundamental observations which have made the Observatory the centre of the astronomical world The chief promoter of the Observatory was Sir Jonas Moore (1617–79), surveyor-general of the Ordnance in the time of Charles II, and it was he who obtained for John Flamsteed the position of "Royal Observator" Moore's headquarters were in the Tower of London, and when he was buried there a salute of sixty-two guns was fired, marking his age The list of the Astronomers Royal who in turn have directed the Observatory, with the dates of their appointments, is as follows 1675, Rev John Flamsteed, 1721, Edmond Halley; 1742, Rev James Bradley, 1762, Rev Nathaniel Bliss, 1765, Rev Nevil Maskelyne, 1811, Rev John Pond, 1835, Sir G B Airy, 1881, Sir William Christie, 1910, Sir Frank Dyson, 1933, Sir H Spencer Jones Some of these will be met with again in the course of the survey, but here it may be mentioned that Halley and Pond are buried together in Lee Churchyard, in a grave kept in order by the Admiralty

Almost due south of Greenwich are Chislehurst, Farnborough and Down One rector of Chislehurst was the scientifically minded Rev Francis Wollaston, and in the churchyard, without any memorial, lies his son William Hyde Wollaston (1766–1828), "a mineralogist of the first order" and other things beside Within six months of his death, the still more distinguished Thomas Young (1773–1829) was buried in the churchyard of St Giles, Farnborough, and his memorial tablet is in the church He had died in London, but was connected with Farnborough through his marriage with Eliza Maxwell, of Tubbendens House, a beauty spot then, but now almost derelict It was thirteen years after Young's death that Darwin, then thirty-three, made Downe his home, leaving it but little until in 1882 his remains were borne to Westminster Abbey Through the generosity of Sir George Buckston Browne (1850–1945), Down House and its grounds have been placed in the custody of the British Association, and visitors can now stroll through the field made famous by Darwin's observations on earthworms and see the study from which came the epoch-making book "On the Origin of Species by means of Natural Selection" Among the many naturalists who visited Darwin was Prof Haeckel, twenty-five years his junior, and after the visit Haeckel described how Darwin's carriage carried him from the railway station to the house, where he was greeted by "a tall and venerable figure, with the broad shoulders of an Atlas supporting a world of thought . The cordial, prepossessing expression of the whole face, the gentle mild voice, the slow, deliberate utterance, the natural and naive train of ideas which marked his conversation captivated my whole heart in the first hour of our meeting "

Zigzagging across the county from Downe, a traveller can, if he wishes, see at Shoreham, in the Darenth Valley, the house and grave of the geologist Sir Joseph Prestwich (1812–96), at Dartford the tablet on the church to Richard Trevithick and at Northfleet the memorial erected by Swedish industrialists to Carl Daniel Ekman (1845–1904), the pioneer of the sulphite pulp industry The village of Meopham, about six miles south of the Thames, was where the elder John Tradescant was married and the younger born, and in another direction is the village of Longfield, in the church of which members of the University of Cambridge placed a memorial window to the Rev Thomas Plume (1630–1704) As vicar of Greenwich, he had known Flamsteed and had preached before Evelyn and Pepys, and as Archdeacon of Rochester he had lived at Longfield Court At his death, he left nearly £2,000 for founding a chair of astronomy and erecting an observatory at Cambridge The first Plumian professor was Newton's young colleague Roger Cotes, and among his successors have been Airy, Challis, Sir George Darwin (who was born at Down House) and Sir Arthur Eddington The present occupant of the chair is Prof Harold Jeffreys In his benefactions, Plume was but following in the footsteps of his father, who had given a library to Malden, Essex, Plume's birthplace

Plume's seventy-four years overlapped the lives of the younger John Tradescant (1608–62), of Elias Ashmole (1617–92) and of Dr Robert Plot (1640–96), whom Oxford has cause to remember Tradescant gave his collection of rarities to Ashmole, who added his own collection and gave the whole to the University, Plot becoming the first curator An energetic man, writing on natural history, lecturing on chemistry and editing the *Philosophical Transactions*, Plot had his home at Sutton Baron, south-west of Sittingbourne, and on his memorial in Borden Church he is shown as a winged warrior with iron-tipped spear slaying a monster Still further to the eastward, in the Faversham district, lies Ottenden Church and Ottenden Place, at the latter of which in 1729 the Charterhouse pensioner, Stephen Gray, with the Rev Granville Wheler (1701–70), showed that electricity could be carried along hundreds of feet of thread Wheler is buried in Ottenden Church, and his descendants still occupy Ottenden Place Still deeper in the county, and near the Sussex border, is Hawkhurst, long the home of Sir John Herschel and his family One day he had as his guests Adams and Leverrier, the discoverers of Neptune He died at his house, Collingwood, on May 12, 1871, and was buried in Westminster Abbey beside Newton By-passing the town of Ashford, the birthplace of the divine and mathematician, John Wallis (1616–1703), who lies in St Mary's, Oxford, and travelling due east, Hythe and Folkestone are reached In the former, on 31 High Street, is a tablet marking the birthplace of Sir Francis Pettit Smith (1808–74), the chief promoter of screw propulsion and one time curator at the Patent Office Museum, now a part of the Science Museum, while in the latter, in the parish church, is to be seen the brass to Harvey's mother, "a godly harmless woman, a quiet neighbour, a friendly matron", and on the cliffs Bruce Joy's statue of Harvey himself, who is depicted "holding the heart of a deer in one hand, while with the other he is feeling the pulsation of his own" August 6, 1881, was a gala day in Folkestone with a banquet, a concert, a holiday for the Harvey School and a train-load of visitors who came to see the statue unveiled by Richard Owen

Entering the county of Sussex from the south of Kent, the visitor will find a series of towns and villages all containing reminders of the progress of science First comes Rye, in the cemetery of which lies the Rev C M Ramus (1821–95), who eighty years ago experimented with boats with stepped hulls, the earliest form of the hydroplane Next comes Battle, in the vicinity of which the pioneer of the power loom, the Rev Edmund Cartwright (1743–1823), and the pioneer of the electric telegraph, Sir Francis Ronalds (1788–1873), spent their later years Cartwright's memorial is in Battle church, and that to Ronald in Battle cemetery North-west of Battle lies the village of Brightling, and to the south-west is the magnificent fifteenth century brick castle of Herstmonceux, in the grounds of which are being set up the telescopes of the Royal Observatory Brightling had its observatories more than a century ago, erected by the rich eccentric bachelor, "Jack" Fuller, of Rose Hill, now Brightling Park The son of a parson and born in 1756, he did all sorts of strange things, for besides his two domes he erected Brightling Needle, and a score of years before he died built a great pyramid in the churchyard, beneath this pyramid he lies, the only inscription being the verse from Gray's "Elegy" ending "The paths of glory lead but to the grave" He died in 1834, having the year before founded the Fullerian professorships of chemistry and physiology at the Royal Institution, Faraday holding one and Dr Peter Mark Roget the other Fuller's bust is in the church

But science in Sussex has tended to centre around her geology, and at one time no name was better known than that of the Lewes surgeon Gideon Algernon Mantell (1790–1852), who explored, excavated and collected, and then wrote and lectured so that all could understand He is buried in West Norwood Cemetery, London, but his Lewes home is marked by a tablet "His gig and groom," wrote Gordon Hake, "were models as they waited at the door His coat of arms embraced your vision as it shone in the fanlight and whispered of greatness within He was tall, graciously graceful and flexible, a naturalist, realizing his own lordship of creation " Three-quarters of a century after Mantell came the Lewes solicitor, Charles Dawson (1864–1916), a Lancashire man, who in 1912 in the old river gravel at Piltdown, near Fletching, about seven miles north of Lewes, found parts of the Piltdown skull, *Eoanthropus dawsoni*, as Smith Woodward christened it That spot, too, is marked by a tablet

Before leaving Sussex a word should be said of Sir George Wyndham, Earl of Egremont (1751–1837), of Petworth Castle, in West Sussex, who from his school-days displayed the characteristics of a liberal-minded patrician He once aided Mantell, but long before that, in 1784, he had as a guest the Hungarian astronomer Baron von Zach (1754–1832), and it was von Zach who, among a heap of old stable records at the Castle, found the astronomical papers of the Elizabethan mathematician Thomas Harriot (1560–1621), one of the first in England to use a telescope and observe sunspots

Travelling northward across the Downs and the Weald of Sussex, so thoroughly explored by Mantell, just inside the border of Surrey are Burstow to the east and Hindhead and Haslemere to the west, the latter being the last home of the physicist John Tyndall, who died there at the age of seventy-three on December 4, 1893, through a tragic mistake Irish by birth and temperament, he became as a son to Faraday at the Royal Institution, and succeeded him as superintendent He had married rather late in life and his widow survived him forty-seven years, passing away in August 1940 at the age of ninety-five As a mountaineer, Tyndall had made the first ascent of the Weisshorn, and within sight of the mountain Mrs Tyndall set up a granite monolith to his memory, and later on in 1931 gave to the National Trust the Tyndall Wood at Haslemere

Hindhead and Haslemere are in the uplands of Surrey, but Burstow is in the flat agricultural district around Horley Flamsteed was rector of this parish from 1684 until his death With his wife he lies in the chancel of the church, where a window was erected to his memory in 1887 by a local resident, J T Tustin, and from the steps of this chancel Sir H Spencer Jones delivered an address at a service held on August 18, 1946, to commemorate the tercentenary of Flamsteed's birth Farther north, between Dorking and Guildford, lies Albury, the scene of the labours of the Rev William Oughtred (1575–1660), friend of many mathematicians, who during his fifty peaceful years as rector wrote among other works his "Clavis Mathematicæ", a much esteemed book which gave the world the algebraical signs '×' and ' ' All around this district are beautiful scenes and fine gardens, and not far away across the Guildford–London road are the Wisley Gardens of the Royal Horticultural Society The other great Surrey Gardens, the Royal Botanic Gardens, founded in 1759 and associated with the work of Aiton, the Hookers, Thiselton-Dyer and others, are at Kew, and it is this corner of the county which is richest in scientific interest As early as 1725, Samuel Molyneux (1689–1728) set up a telescope at Kew Green to test some of Hooke's views regarding the distance of the stars, and here he was sometimes joined by Bradley In 1758 George III, anxious to observe the transit of Venus of the following year, founded his own observatory at Kew and appointed the elder Stephen Demainbray (1710–82) as his astronomer Not much was achieved in astronomy at the observatory, but in 1843 it came under the control, at first, of the British Association and then of the Royal Society, and ever since has been widely known for its meteorological work, among its directors have been Ronalds, Balfour Stewart, Charles Chree and also G M and F J W Whipple

Mortlake, Richmond and Kingston, too, have something for the man of science At Mortlake are buried the Elizabethan alchemist Dr John Dee (1527–1608), the astrologer and almanac maker John Partridge (1644–1715) and the nineteenth century sanitary reformer Sir Edwin Chadwick (1800–90) At Sheen Lodge, Richmond, Sir Richard Owen, whose body lies in Ham churchyard, spent many years of his life, and in Kingston Museum are preserved some of the relics of Edward Muybridge, one of the pioneers of the cinema

It may well be that some visitors to the South Bank Exhibition will admire London's bridges, and for these it is worth mentioning that in the churchyard and church at Chipstead, south of Croydon, Surrey, are the tomb and monument to Sir Edward Banks (1770–1835), the foremost civil engineering contractor of his day, who built to the designs of John Rennie the old Southwark and Waterloo Bridges and the present London Bridge, all three of which are depicted on his monument.

If Berkshire, Hampshire, Wiltshire and Dorset cannot claim so many scientific shrines as the three south-eastern counties, no naturalist will overlook Selborne in Hampshire, the home of Gilbert White (1720–93), where the National Trust owns some 240 acres over which White so often strolled; no photographer will willingly miss the beauties of the home of Fox Talbot (1800–77), Lacock village and Lacock Abbey, in Wiltshire, generously given to the Trust by Miss Matilda Talbot, his granddaughter; and no geologist touring Dorset will fail to visit Lyme Regis church and see the window erected by the Geological Society to the memory of Mary Anning (1799–1847), who as a girl of twelve obtained from the cliffs the fossil remains of an *Ichthyosaurus*. Lyme Regis was also the birthplace of John Gould (1804–81), the traveller and ornithologist, one time curator of the Museum of the Zoological Society. In the same county, in an old Elizabethan mansion at Stalbridge, Robert Boyle passed some of his youth, in Purse Candle church lies Harvey's friend, Nathaniel Highmore (1613–85), and at Winsford Eagle, another famous medical man, Thomas Sydenham (1624–89), was born. The most popular London practitioner of his time, he was buried in St. James's, Piccadilly, now in ruins. The tablet over his grave was erected by the Royal College of Physicians.

The oldest Berkshire man of science of note appears to have been John Blagrave (d. 1614), who after studying at St. John's College, Oxford, retired to his home near Reading, writing books and recommending mathematical studies "to Gentlemen of Abilities and Leizure, as they were not mere Amusements for Scholars and speculative Persons, but of general Advantage to the necessary Affairs and Business of Life". He wrote on dialling, the staff and the astrolabe, and his monument in the church of St. Lawrence, Reading, shows a man in cloak, cassock and ruff, with a globe in one hand and a quadrant in the other. Sir Samuel Morland (1625–95) was another Berkshire man, his birthplace being Sulhamstead Bannister, seven miles from Reading. There was no quiet retirement for him, for he liked to be in the limelight, and if not engaged in public affairs was filling his Vauxhall house and later his Hammersmith house with ingenious mechanisms of all sorts. He had the misfortune to lose his sight before he died, and he was buried in Hammersmith Chapel. He was four times married and two of his wives, Carola (d. 1674) and Ann (d. 1680), are commemorated in Westminster Abbey. Berkshire was also the first home of Francis Baily (1774–1844) and the last of David Gregory (1661–1708) and William Lassell (1799–1880), all astronomers and all Fellows of the Royal Society. Baily was the son of a Newbury banker; but his days were spent in London, where he helped to found the Royal Astronomical Society, of which he was president four times. Lassell was one of his successors in the chair; but he began life as a Lancashire brewer. He had several observatories, one at Malta; but the last was at Maidenhead, where he died on October 5, 1880. There was no astronomical society in Gregory's day; but he did good work as the Savilian professor at Oxford and counted among his friends Flamsteed and Newton. There is a handsome memorial to him in St. Mary's Church at Maidenhead.

Leaving Berkshire for Hampshire, near a line drawn due south from Reading, will be found the village of Eversley and then the town of Alton and the village of Selborne. In the time of the Rev. Charles Kingsley (1819–75), the rectory and the church at Eversley and the surrounding district were often the object of a pilgrimage, for Kingsley would not only have every man a Christian but also a naturalist. It was this that gave birth to his "Water Babies". His admirers came from every age and every class, and after his burial at Eversley on January 28, 1875, a naval officer wrote: "I have been at many State funerals but never did I see such a sight as Charles Kingsley's". He must have known the town of Alton, with its botanical reputation; but he could only have known William Curtis (1746–99), who was born there, through his writings. For most of his life Curtis was an apothecary at 51 Gracechurch Street, London, and the plaque now on the site of his house is one of the very few to men of science in the City. Curtis was buried in St. Mary's churchyard, Battersea, and at the commemoration of his bicentenary in 1946 steps were taken to restore his tomb. Of Selborne it is not necessary to write, for who has not dipped into White's "Natural History"? Farther south in the county, near Winchester, is Sparsholt, where Sir George Buckston Browne in 1945 was laid beside his wife, while still farther south is the magnificent Abbey at Romsey, in which are commemorated two most versatile and ingenious men, Sir William Petty (1623–87), the son of a Romsey clothier, and the Rev. E. L. Berthon (1813–99), vicar of the parish for many years. All who know about ships have heard of Berthon's screw-propeller and collapsible boats, if not his nautical log; but he was also expert with telescopes and microscopes. Petty, too, knew something of ships, having served in the Navy; but anatomy, physic, music, surveying and economics all occupied his time and thoughts, and he has been called "The Father of Political Economy".

Though the home of Fox Talbot will probably be the favourite scientific shrine in Wiltshire, the county can claim among its notable men at least three who were original Fellows of the Royal Society. The first of these is Sir Christopher Wren (1632–1723), who was born at East Knoyle, near Salisbury; the second, Dr. Thomas Willis (1621–75), who was born at Great Bedwyn, not far from Marlborough, and who was buried in Westminster Abbey at a cost of little short of £500; and the third, Seth Ward (1617–89), a native of Hertfordshire, who died in London but is buried and commemorated in Salisbury Cathedral. William Oughtred was one of his instructors, and John Wallis one of his collaborators. He was first Savilian professor of astronomy (1649–61), then Dean and Bishop of Exeter (1661–67) and finally Bishop of Salisbury. Then, too, Wiltshire can claim not only the Talbot family but also the Story and Maskelyne families, from which came Nevil Maskelyne (1732–1811), the Astronomer Royal, and his grandson, Nevil Story-Maskelyne (1823–1911), whose services to mineralogy at the British Museum and Oxford will long be remembered. The home of the Story-Maskelynes was near Swindon, and its annals have been recorded in the late Mrs. Arnold-Forster's "Basset Down". Wiltshire was also the last home of Sir Oliver Lodge, who died on August 22, 1940, and was buried at Wilsford, six miles south of Devizes.

SUBSTITUTION OF NITRIC FOR SULPHURIC ACID IN THE PRODUCTION OF PHOSPHATE FERTILIZERS

By Dr G. R. DAVIES
Chemical Research Laboratory, Teddington

SULPHURIC acid is, perhaps, the most important of all chemicals, and the amount consumed usually provides a reliable index to the industrial virility of a country In the United Kingdom the annual production of the acid has increased steadily over the years, rising in the past decade from about 1,200,000 tons to more than 1,800,000 tons in 1950. More than fifty per cent of the recent production has been made from sulphur, the remainder being manufactured from pyrites, spent oxide, zinc concentrates and anhydrite Native sulphur is the preferred raw material because of its high purity, low shipping costs and because of the lesser operating costs of plants burning sulphur as compared with those using pyrites Considerable concern has therefore been caused in recent months by the statements which have been issued regarding the limited extent of the reserves of brimstone in the United States, which is the major producer of native sulphur At the present rates of consumption these reserves may last only ten or eleven years This has led the United States to reduce its exports, and British imports of sulphur have therefore been decreased by some thirty per cent Although the reserve position in regard to pyrites is much more secure, yet any conversion of sulphur-burning plants to enable them to use pyrites must cause serious dislocation and must require some years to complete The present position therefore calls for strict economy in the use of sulphuric acid

The largest consumer of the acid in Britain is the fertilizer industry, which last year used 435,500 tons in the manufacture of superphosphate, while a further 260,000 tons was employed in the manufacture of ammonium sulphate A reduced production of sulphuric acid must lead to a decrease in the manufacture of artificial fertilizer and to a lowered productivity of British farm lands Of course, there are numerous other users of sulphuric acid, such as the rayon industry, of which much has been heard recently and which itself consumes more than 200,000 tons of acid annually

Because of the difficulties that might arise in maintaining adequate supplies of sulphuric acid to the fertilizer industry, the Chemical Research Laboratory, Teddington, has been studying for the past two years the possibility of making phosphate fertilizers by methods which might effect a saving in the amount of sulphuric acid used The most obvious alternative to sulphuric acid is nitric acid, for its production does not call for the use of imported raw materials, while the nitrogen value of the acid is recoverable in the form of a nitrogenous fertilizer, and this offsets to some extent the greater cost of the acid as compared with sulphuric acid Unfortunately, the action of nitric acid on phosphate rock leads to the production of a fertilizer containing much calcium nitrate, which is a highly hygroscopic substance and causes the fertilizer to become damp and difficult to use Consequently, the work at the Chemical Research Laboratory has largely been confined to the use of mixtures of nitric and sulphuric acids The action of these acids on phosphate rock leads to the formation of monocalcium phosphate, calcium sulphate and calcium nitrate, and there seemed the possibility that the inert calcium sulphate might so coat and protect the calcium nitrate as to prevent it absorbing moisture or, at least, that it would so slow down the rate of adsorption of moisture as to render the product usable without further treatment Actually, it has been found that products made in this way are more stable to atmospheric conditions than when nitric acid is used alone The maximum amount of nitric acid which can be tolerated in order to give a product having a low absorption of moisture is when the mixture of acids contains about 2 mol of nitric acid to one of sulphuric Even with this mixture of acids the fertilizer made from it is somewhat hygroscopic if the theoretical amount of acid is used to decompose the rock completely, but when only eighty per cent of this amount is used the material does not pick up any appreciable amount of moisture at relative humidities below seventy per cent The reaction between the phosphate rock and nitric–sulphuric acid mixtures is quite vigorous and goes to completion much more rapidly than when sulphuric acid is used alone as in ordinary superphosphate manufacture The product also sets quickly to a dry, crumbly product, although it will dry out a little further in the course of a day or two The fertilizer made in this way contains about 18 per cent of phosphate (reckoned as P_2O_5), of which 86 per cent is water-soluble, while 96 per cent is dissolved by 2 per cent nitric acid The nitrogen content is about 4 per cent. There is very little evolution of hydrofluoric acid during the reaction and virtually no loss of nitric acid as nitrous fumes

Attempts have been made to include potassium chloride in order to provide a complete fertilizer, but with any substantial addition of this substance the products are more sensitive to atmosphere moisture

A report on the work has been presented to the Fertilizer Manufacturers' Association

SCIENCE AND BREWING

WHETHER brewing is an art or a science continues to be a question for debate, but it cannot be doubted that the impact of science on the brewing industry is becoming ever more insistent Economic conditions are enforcing a more considered use of raw materials and plant, on the other hand, the selection of new barleys suited to changing agricultural conditions, malting for brewing, the selection and conservation of desirable yeasts, the development of acceptable disease-resistant hops and a better understanding of the many processes of mashing, fermentation, maturation and others making up what is colloquially known as brewing, are only a few of the numerous questions calling for scientific investigation It was timely, therefore, when the Microbiological Group of the Society of Chemical Industry, the Incorporated Brewers' Guild and the Royal Microscopical Society held a symposium on brewing on March 14 in the Chemistry Department, King's College, Newcastle upon Tyne

In an opening contribution on "Beer and the Biochemist", M H Van Gruisen (Newcastle Breweries, Ltd) paid tribute to the help which science has given and is giving to the brewer in enabling him to produce a stable and uniform product from unstable and variable raw materials. Thus, malting barley has received much attention from agriculturists and plant breeders, with the result that, through selection and breeding within the past fifty years, the brewers' extract of normal malts has risen by four or five pounds per quarter, while at the same time the farmers' yield per acre has also increased.

In the hop garden the main task has been the continued warfare against various pests and diseases to which the plant is prone. Wilt-resistant varieties have been bred, and these are at present undergoing large-scale brewing trials. Hops with a high resin content have also been reared to replace American hops which are no longer available.

Finally, of the ingredients of the brew, the water or 'liquor', the composition of which is often thought to account for the pre-eminence in brewing of certain areas, such as that of Burton-on-Trent, must not be overlooked. Now, with analytical methods available and the effects of minor constituents on various reactions in the brewing process better understood, breweries with less-favourable water supplies are able to make the necessary adjustments.

From the biochemical point of view, the brewing process is in effect the production of a culture medium for yeast. The need for a thorough understanding of wort constituents and yeast nutrition has led to a considerable volume of research on starch and plant proteins.

During malting, enzyme systems develop which in the mash tun break down the starch of the original barley corn into maltose and dextrins of various degrees of complexity. The ratio of these fermentable to non-fermentable products may be controlled by mashing conditions and are of importance to the brewer. Maltose, by its breakdown to alcohol and carbon dioxide, yields to the yeast the energy required for reproduction, while the unfermentable dextrins give character to the finished beer.

The protein breakdown largely occurs during malting. The amino-acids and some of the very simple di- and tri-peptides are potentially utilizable by the yeast as nitrogen sources for building new cells. These amino-acids may be used directly or may supply nitrogen by transamination or deamination, by the Ehrlich mechanism, to give the alcohol corresponding to the amino-acid. This factor is of some importance, as the resulting higher alcohols contribute to the aroma of the beer. Of the more complex nitrogenous products, most are removed during the brewing process, but the β-globulin fraction survives in combined form with hop tannin. Albumen degradation products are probably responsible for the head-retaining properties of the beer, but globulin tannate is the cause of chill and oxygen hazes which are particularly detrimental to bottled beers.

In a second contribution, "Enzymes and their Significance in Brewing" were discussed by Prof. I. A. Preece (Heriot-Watt College, Edinburgh). He said that, if the term brewing be restricted to mean the preparation of a specialized medium for yeast growth and fermentation, the enzymes to be considered were those of barley and malt, and the reactions those concerned in malting and mashing; the subsequent boiling of the wort with hops inactivates residual enzymes and stabilizes the composition of the fermentable medium.

The enzymes concerned may be considered to form two groups, of which the first contains the general metabolic enzymes already present in the raw barley. Particular significance here is attached to the dehydrogenase system, the activity of which in living corns permits determination of the germinative capacity of a barley sample, so giving rapid distinction between dead corns and those which are merely dormant. However, since the power to germinate is not accurately paralleled by retention of dehydrogenase activity, samples which have suffered a moderate degree of heat damage may give misleading results in the test. Other enzyme systems in this general group include catalase, which again shows differences of behaviour in living and dead corns; phosphorylase, associated with starch synthesis; and the interlinked systems concerned in aerobic and anaerobic energy release.

The second group of special metabolic enzymes includes many where reversibility of action has not been demonstrated; to some extent, these enzymes resemble those of the animal digestive tract. It is a main purpose of malting to allow development of these enzymes, or—if they are already present in the raw grain—to facilitate their extraction in the subsequent mashing. A second main purpose is the modification of the hard barley grain, the intense enzymic activity during germination causing hydrolysis of cell-wall and related materials, so permitting adequate crushing of the grain and reducing the viscosity of the extract obtainable; at the same time, a proportion of the nitrogenous material is hydrolysed to provide yeast-feeding compounds, and α-amylase is produced in amounts which permit speedy saccharification of starch to be achieved in the mashing process. The kiln treatment of the germinated grain produces a malt dry enough for safe storage, stabilizes its composition, allows control of the proportions of the various enzymes present, and adds colour and flavour.

Little cytolysis or proteolysis occurs during the British infusion system of mashing, and quantitatively the main enzymic reaction is starch hydrolysis. This produces fermentable sugars (glucose, maltose, maltotriose) and unfermentable dextrins (branched and unbranched α-dextrins) as a result of the joint activity of α- and β-amylases. The heat instability of the latter near the temperature of an infusion mash (for example, 65° C.) permits a high measure of control of the proportions of fermentable and unfermentable materials formed, since the production of maltose by β-amylase in mashing decreases sharply as the temperature is raised, while the α-amylase activity is but little affected in the range 63–67° C.

In the final session, Dr. A. H. Cook (Brewing Industry Research Foundation) spoke on "The Significance of Microbiological Research in Brewing". This significance does not so much extend into the past as reach out into the future; despite three centuries of microbiological history, this science has only acquired any coherent form as a result of a few epoch-making advances, such as that of the antibiotic field, of the comparatively recent past.

Consideration shows that antibiotics may have some, if limited, use in the brewery. Subtilin is receiving attention as a preservative of foodstuffs, while antibiotics in a more limited sense may play a part in the orderly development of the individual organisms comprising a normal brewers' yeast; a prominent example is the development of *Brettanomyces* species in maturing cultures of *Saccharomyces cerevisiæ*. Although not of microbial origin, humulone and lupulone have an antimicrobial action, and the suggestion has been made that lupulone may offer a means of ingress to the antitubercular field. In adding to such approaches, many physical methods of controlling yeast and bacterial growth in the brewery have still to be explored. Ultra-violet sterilization has not been without success; ultrasonic treatment may be of value in this way as well as in rapid 'conditioning' (so far as protein precipitation is concerned), and cathode-ray treatment, now receiving intensive examination in processing foods, may provide another sterilization treatment lacking the disadvantages of pasteurization.

Turning more particularly to some aspects of brewery fermentation, only very recently has there become available even a partial view of the carbohydrates and of the amino-acids and other nitrogenous constituents of brewers' wort, as well as of their value as yeast nutrients and substrates. A brewery yeast, however, must obviously effect a composite fermentation, and in studying the component parts the National Collection of Yeast Cultures, which will be a responsibility of the Brewing Industry Research Foundation, seems likely in many instances to play an important part. Subsidiary collections of brewers' yeasts and of genetically pure and hybrid yeasts should have a peculiar research interest. The hybridization of yeast has only recently been intensively studied, mainly by Winge and his associates, who have provided much of the available data on the sporing and on the haplo- and diplo-phases of certain species of *Saccharomyces*. This work has proved valuable in the selection of hybrids for simple fermentation yeasts, but its exploitation in the brewery has hitherto been less marked. Such exploitation is, however, brought nearer by recent work of Thorne, who has succeeded in hybridizing several British top-fermentation brewery yeasts. Selection of the hybrids reveals that flocculence is a genetically controlled character. The observed segregation of the readily mutating hybrids makes it appear that not less than three genes are concerned with the appearance of flocculence, while still another seems concerned with inhibiting the expression of flocculence.

There are innumerable other points at which microbiology touches brewing. These range from the use of insecticidal washes in hop culture to the importance of wild yeasts in brewery casks, from the disposal of potentially toxic materials by yeasts to the formation of valuable vitamins. These are but a few of the problems which research in the not too distant future should do much to answer.

OBITUARIES

Mr J W. Tutcher

By the death, on April 11, of John William Tutcher, in his ninety-third year, geology has lost one of its outstanding amateur workers. He will be remembered particularly for his many contributions to the study of the palæontology and stratigraphy of the Jurassic rocks of the Bristol district, and for his pioneer work in scientific photography.

Until recent years Mr Tutcher carried on business as a bootmaker in Bristol, but most of his leisure was devoted to geology. In his younger days this frequently involved cycling out before business hours to the quarries of Dundry Hill and, when some particularly interesting bed was being uncovered, walking back with his cycle loaded with specimens. When his own lameness is borne in mind, one could only marvel at his success in bringing together and preparing the collections which overflowed into all parts of his home. Apart from numerous specimens which found their way into other museums, the Bristol City Museum has more than 20,000 fossils from the Tutcher Collection, all with details of locality and precise horizon. At all times his specimens were placed at the disposal of other geologists, and many younger geologists owe much to his ready help. He wrote comparatively little himself, unless very strongly persuaded; but he contributed several papers to the *Proceedings of the Bristol Naturalists' Society* and to the *Quarterly Journal of the Geological Society*. For many years he worked with the late S. S. Buckman, and his name appears on the title-pages of the seven volumes of "Yorkshire Type Ammonites" and "Type Ammonites", for which he provided most of the photographs. But his contribution, as Buckman always freely admitted, was not confined to the preparation of plates; his great knowledge of the detailed stratigraphy of the Lias in particular was of great service to his collaborator.

Mr Tutcher was probably the first person in Britain to build a piece of equipment for the lighting and photography of fossils, a work in which he acquired such skill that, twenty years ago, it was nearly always possible, on skimming a volume of geological papers, to pick out by their high quality the illustrations prepared by Tutcher; for in this field he was always ready to help others, and it has been estimated that he provided for reproduction photographs of several thousand fossils.

Mr Tutcher was awarded the Lyell Fund by the Geological Society in 1924, and received the honorary degree of master of science from the University of Bristol in 1927. He was for many years a prominent member of the Bristol Naturalists' Society, of which he became president. He was also president of the South-Western Naturalists' Union. His modesty and kindness will long be remembered by those who were privileged to work with him. A. E. Trueman

Prof F. K Kleine

Prof Friedrich Karl Kleine, a distinguished pioneer and leader in the field of research into tropical diseases of man and animals in Africa, died in Johannesburg on March 22 at the age of eighty-one.

Kleine was born on May 14, 1869, at Stralsund, a Baltic port of Germany. He was the son of a medical practitioner, and early decided to follow his father's profession, entering the University of Halle as a medical student. After qualifying, he worked at the Pharmacological Institute in Halle, and at the University Clinic in Kiel, and served also for a time in the Army Sanitary Service. In 1900 he was appointed to the staff of the Institute for Infectious Diseases in Berlin, and there became personal assistant to Prof Robert Koch, the discoverer of the tubercle bacillus and of the cholera vibrio. In 1903 Kleine went with Koch to Southern Rhodesia to investigate a disease, thought to be redwater, in cattle, which was causing great economic losses. Their investigations showed the disease to be tick-borne and distinct from redwater, and they named it 'African coast fever'. This finding led Kleine to become one of the first to work on the developmental stages of the parasite of tick fever in dogs—a story which is still not properly elucidated. During 1906–7

Kleine was seconded for service with the German Sleeping Sickness Expedition in East Africa under Koch's leadership His particular researches related to preventive measures against the disease Later he returned to East Africa as leader of a campaign against sleeping sickness On this visit he made the important discovery that the trypanosome causing the disease is not carried from the sick to the healthy by the tsetse fly in a direct mechanical way, as had been believed, but undergoes a fairly prolonged cycle of development in the fly after the fly has fed on infected blood This discovery by Kleine opened a new road to investigators, and led to many advances in knowledge of the epidemiology of trypanosome diseases

After an interruption to research caused by the First World War, Kleine was granted permission in 1921 to visit Northern Rhodesia and the Belgian Congo to test a new drug, 'Bayer 205' ('germanin'), in human and animal trypanosomiasis In 1926 he was nominated as the German delegate on the League of Nations International Commission on Human Trypanosomiasis, and, working in Uganda, Kenya and Tanganyika, he investigated problems of immunity against trypanosomes in natives living in chronic foci of sleeping sickness

In 1933 Kleine was elected president of the Robert Koch Institute in Berlin, where he continued his researches on relapsing fever, foot-and-mouth disease, rinderpest, trypanosomiasis and other tropical and veterinary diseases, revisiting Southern Rhodesia and East Africa during 1934–35, and South Africa during 1936–37 In 1947 he retired to South Africa, where he spent the last days of his life

Kleine's patent honesty, his conscientiousness in research, his sense of humour, and unvarying courtesy won for him many friends among his colleagues and British co-workers in Africa He married Hanna Ockelmann, who accompanied him on his many journeys and assisted him in his scientific work during the last thirty years of his life, and who survives him They had one son, who was killed in Bucharest in the Second World War

R L Sheppard

Mr. A. S. E. Ackermann

Mr A S E Ackermann died at the age of eighty-three on April 7. He practised as a consulting engineer in Westminster and his work covered a wide range

Though born in London, Ackermann received his first training at the South African College, now the University of Cape Town Later, in London, he was one of the early students at the City and Guilds College, where, after gaining his associateship in civil and mechanical engineering, he was employed by Prof W C Unwin as his assistant, and many years later was elected a Fellow of the College

Ackermann made good use of his scientific training and was always an ardent advocate of adequate qualification for all practising in any branch of science He took the degree of B Sc (Eng) and later served as deputy chairman of Convocation of the University of London, after having been for eleven years honorary general secretary of the London Graduates Association He was secretary of the Society of Engineers for more than thirty years, and for several years was the honorary general secretary of the British Section of the International Association of Journalists

In the many branches of engineering in which he worked and gave advice, Ackermann's approach was always scientific and logical, and for that reason he was an extremely good expert witness and was successful in cases relating to noise and smoke nuisance and in 'ancient lights' disputes He believed that it was possible to do effective practical research without the use of complex apparatus, and gave proof of this in 1919 when he did pioneer work investigating the physical properties of clay, using only household appliances The results were given in three papers published by the Society of Engineers, in which he established a critical point which he called 'the pressure of fluidity'

In about 1907 Ackermann became interested in the development of power from solar energy, and as engineer to a syndicate he was responsible for the designs and experiments made with several plants The first of these was tested in America, and the final plant, which was tested in Egypt, was more elaborate, by using focusing mirrors, it produced steam at a low pressure, which was supplied to a specially designed engine A full description of this test, together with particulars of all earlier attempts to develop solar energy, was given in a paper by Ackermann published by the Society of Engineers in 1914

The examination of commonly accepted statements which could be checked and refuted on a scientific basis attracted Ackermann, and the collection of such cases became an absorbing interest to him In 1907 he published a collection of these cases under the title "Popular Fallacies", which proved very successful He continued to collect fallacies in ever widening fields, and in the fourth edition of this work, published in 1950, no less than two thousand are treated and classified under twenty-seven headings

Ackermann was a familiar figure at the meetings of numerous engineering and scientific societies and will be missed by many He married in 1901, and his widow and two daughters survive him

J S Wilson

Dr. H J Finlay

Micropalæontology in New Zealand has suffered a serious loss in the sudden death of Dr Harold John Finlay at his home in Karori, Wellington, on April 7 Born at Cronilla, India, in 1901, Finlay went with his parents to Dunedin, New Zealand, within a few years He received his primary and secondary education at the Normal School there, and, after a brilliant career at the University of Otago, graduated M Sc in 1921 with first-class honours in chemistry For two years, as John Edmond Fellow, he did post-graduate work in chemistry, and for the next three years was National Research Scholar in palæontology under Prof W N Benson For the following three years he was biologist to the Fisheries Branch of the Marine Department

During the period 1923–31, Finlay published about thirty papers on molluscan systematics, mostly in the *Transactions of the New Zealand Institute* (later, *Trans Roy Soc N Z*) but some in the *Proceedings of the Malacological Society of London* In 1926 he was awarded the Hamilton Prize for his published work, and in the following year he obtained his D Sc with an outstanding "Further Commentary on N Z Molluscan Systematics" (*Trans N Z Inst*, 57, 320) Other important papers are, "New Shells from N Z.

Tertiary Beds, Parts 1–3" (*Trans N Z Inst* , 55; 56 , 61) , and "Recent Mollusca of the Chatham Islands" (*Trans N Z Inst* , 59)

During 1933 and 1934, as part of its oil prospecting work, Taranaki Oilfields and Vacuum Oil Co. employed Finlay to take up a study of the Cretaceous and Tertiary Foraminifera In this new field his keen mind and ability for intense application, together with his schooling in molluscan systematics, soon produced highly significant stratigraphical results In 1937 he was appointed micropalæontologist to the N Z Geological Survey, and in the next ten years he revolutionized the status of Foraminifera in the stratigraphy of New Zealand with the following papers · "New Zealand Foraminifera Key Species in Stratigraphy, Nos 1–5" (*Trans Roy. Soc N Z* , 68, 69 , and *N Z J Sci Tech* , 28), "The Foraminiferal Evidence for Tertiary Trans-Tasman Correlation" (*Trans Roy Soc N Z* , 76) , and, with J Marwick, "The Divisions of the Upper Cretaceous and Tertiary in New Zealand" (*Trans Roy Soc N Z* , 70)

Finlay was elected Fellow of the Royal Society of New Zealand in 1939, and received from the Society the Hector Medal and Award in 1941

In addition to his scientific activities, Finlay was an accomplished musician, in later years devoting considerable time to serious composition A prelude and fugue of his was publicly performed and broadcast by the New Zealand National Orchestra, and some chamber music trios have been broadcast by instrumental groups J MARWICK

NEWS and VIEWS

Symons Memorial Medal Sir Geoffrey Taylor, F.R.S.

THE Symons Memorial Medal of the Royal Meteorological Society, which is awarded biennially for distinguished work in meteorological science, has been conferred this year on Sir Geoffrey Taylor in recognition of his classical work on atmospheric turbulence Sir Geoffrey's first contribution to the subject arose from his participation as meteorologist in the *Scotia* Expedition to the Grand Bank of Newfoundland in 1913 This expedition followed the loss of the *Titanic* from collision with an iceberg in foggy weather in the Atlantic, and his work was concerned with the modification of temperature and humidity in an air mass by turbulence as it passed out to sea from a continental area or over a progressively colder sea—Grand Bank fog is commonly produced in the warm moist south-easterly air stream which encounters a very high gradient of surface temperature in the ice-chilled waters of the Grand Bank area He made kite observations from the *Scotia* and was able to interpret them in terms of a theory of turbulence which effectively anticipated Prandtl's mixing-length theory of turbulence Later papers followed in the *Proceedings* and *Philosophical Transactions of the Royal Society,* dealing with momentum transfer by turbulence, the drag of the earth on the wind and the variation of wind with height in the planetary boundary layer In 1917 Sir Geoffrey gave a very full discussion of the problem of the formation of fog over land as well as at sea, and devised a fog-prediction diagram for Kew Observatory, using methods which have since been elaborated by others Later he designed a very simple but elegant bi-directional vane for recording turbulent fluctuations in the wind at right angles to the mean motion, and reported on his findings with this instrument in his Symons Memorial Lecture to the Royal Meteorological Society in 1927 Other workers have since made much use of this technique In the 1930's, Sir Geoffrey gave new impetus to the study of turbulence in his now-famous series of papers on the statistical theory of isotropic turbulence This work is very wide in scope and will find application in meteorology as it has already done in other fields of fluid-motion study Sir Geoffrey has, of course, also made many outstanding contributions to other branches of physical science

Elliot Medal of the U.S National Academy of Sciences: Prof J. T Patterson

THE Daniel Giraud Elliot Gold Medal of the United States National Academy of Sciences has been awarded to Prof J T Patterson, director of zoological research in the University of Texas The Elliot Medal is an annual award and is given for an outstanding paper on original research in zoology or palæontology Prof Patterson has made important contributions to genetics, particularly by his papers on isolating mechanisms which have been published in the volume entitled "Studies in the Genetics of *Drosophila* V. Isolating Mechanisms", issued by the University of Texas in 1947 The studies reported in this volume mark the culmination of research in the phylogeny of *Drosophila* by genetical methods which Prof Patterson initiated at the University of Texas more than twenty-five years ago As a combination of experimental and taxonomic investigation it represents a highly significant contribution to research on the problem of species

Sir George Beilby Memorial Fund: Awards for 1950

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have decided to make two awards for 1950, each of one hundred guineas, from the Fund These awards have been made to W A Baker in recognition of his experimental contributions to knowledge of the factors determining the production of sound castings of non-ferrous metals and alloys , and Dr G Whittingham, in recognition of his experimental contributions to knowledge of the combustion products of fuels containing sulphur and their effects on corrosion Mr Baker joined the staff of the Assay Office, Royal Mint, London, as a student assistant and graduated in metallurgy at the University of London as an external student in 1934 Shortly afterwards he joined the British Non-Ferrous Metals Research Association, where he was engaged mainly on such problems as the effects of volume changes and gas evolution in the solidification of metals and alloys, influence of alloy constitution and other metallurgical variables on the casting characteristics of the materials, and the general principles to be observed in developing foundry techniques yielding serviceable castings Recent work in non-ferrous physical metallurgy has included the equilibria between oxygen and phosphorus in molten copper Dr Whittingham is a Cambridge graduate, and in 1942 he joined the British Coal Utilization Research Association and is now the superintendent of the Association's Combustion Department He has studied particularly the formation of sulphur trioxide during the pre-flame and flame combustion of carbon monoxide, hydrogen and hydrocarbon gases containing small amounts of sulphur dioxide This work led to a new theory that sulphur trioxide could be formed in combustion processes as a result of a gas-phase reaction between sulphur dioxide and oxygen atoms His later work has included spectroscopic observations on flames containing sulphur compounds and on the luminescence of burning carbon, and an examination of the effects of fine smoke particles on combustion gases containing sulphur oxides

Cadman Memorial Medal: Dr Robert E Wilson

THE Cadman Memorial Medal of the Institute of Petroleum has been awarded to Dr Robert E Wilson, chairman of the board of the Standard Oil Co (Indiana) After the presentation of the Medal on June 21, at the Royal Institution, 21 Albemarle Street, London, W 1, Dr Wilson will give the third Cadman Memorial Lecture, his subject being "Management and Research in the Petroleum Industry" Dr Wilson was born in Pennsylvania and is a graduate of the Massachusetts Institute of Technology, he began his career as a research associate at the Institute and later was appointed a director of research there In 1922 he became assistant director of research at the Whiting Refinery of the Standard Oil Company (Indiana), later becoming a director and vice-president of the Company He was appointed chairman in 1945 During the Second World War Dr Wilson was chairman of the Committee on Petroleum Economics of the Petroleum Industry War Council

Engineer-Captain Edgar C Smith, O.B.E., R.N. (ret.)

IN *Nature* of April 28 and May 19 are articles by Engineer-Captain Edgar C Smith on memorials to scientific men in Britain These articles open a series which we hope to publish during the course of the Festival of Britain, and are the latest of his numerous historical contributions to *Nature*, *Engineering*, the *Transactions of the Newcomen Society*, and other periodicals Capt Smith has just entered upon his eightieth year, having been born on May 5, 1872, at Newport Pagnell His boyhood was spent at Gravesend, where his father, George Charles Hooper Smith, kept a school After a short period at Finsbury Technical College under John Perry and Silvanus Thompson, he devoted some six years to acquiring a varied workshop experience, mainly in the West Country, and then, at the age of twenty-three, joined the Royal Navy as a direct-entry assistant engineer In the next twenty-seven years he served in the battleships *Trafalgar*, *Sans Pareil*, *Barfleur* and *Magnificent*, the cruisers *Fearless*, *Carnarvon* and *Minerva*, the destroyer *Orwell*, on the staff of the training ship *Britannia*, and in the Royal Dockyards at Hong Kong and Devonport He retired in 1922, and has since devoted himself to scientific biography and the history of naval engineering, studies which began forty-five years ago when the *Orwell* sustained collision damage that kept her in dock at Leith for several months, thus enabling Engineer Lieutenant Smith (as he then was) to explore the libraries and bookshops of Edinburgh and to collect biographical material, some of which he has deposited in the office of *Nature* His labours in the field of naval engineering history have been particularly well timed, for he has been the means of recording the personal recollections of many naval engineers whose service dated back to the days when steam was still auxiliary to sail

Kossuth Awards in Hungary for 1951

WINNERS of the 1951 Kossuth Awards in Hungary, which are given for outstanding work during the past year, have recently been announced Fifteen of the Awards are for 20,000 forints and sixty-nine for 10,000 forints, making a total of nearly a million forints (about £30,000) The Awards are divided between four sections on natural sciences, humanities, arts and literature, and social reconstruction, respectively, those for natural sciences are as follows, the value being 10,000 forints except where otherwise stated *Agricultural Science* Prof G Ubrizsy, for the application of Soviet plant-protection methods and his contribution to the book "Handbook of Practical Plant Protection' *Botany*. Prof R Soó, for work in botanical science *Chemistry* Prof E Schulek (20,000 forints), for research into chlorocyanide compounds, the theory of absorption indicators and methods of gas analysis, L Erdei, for work on the use of ascorbic acids in chemical analysis *Geology* Prof S Vitális, for contributions to geological map-making, Prof A Foldvári, for research into the use of minerals, and the discovery of mineral deposits, Prof M Vendel, for work on the classification of ore deposits *Medicine* Prof Ö Kerpel-Frónius, for research into infantile atrophy and exsiccative toxicosis, Prof A Babics, for research into kidney infections *Mathematics* Prof G Hajos, for work on the study of group principles, Prof P Rózsa, for investigations on recursive functions, G Alexits, for research into orthogonal series analysis *Physics* Prof L Jánossy, for work on cosmic rays, I. Kovács and A Budó, jointly, for work on the examination of molecular spectra *Technology* J Kóta, of the Mine Safety Research Institute (20,000 forints), for research into mine explosions, L Heller, for work on air condensing systems

Royal Botanic Gardens, Kew: Exhibition

BY invitation of the director, Sir Edward Salisbury, 477 members of scientific societies and university students attended at the Herbarium and Library of the Royal Botanic Gardens, Kew, during May 4–5 In the absence of the director through illness, the visitors were welcomed by the keeper, Dr W B Turrill, who briefly outlined the history, organization and work of Kew and summarized the objects of the exhibition that had been staged in the three wings of the Herbarium A large series of beautifully arranged plants and plant specimens illustrated some of the many lines of research on which members of the Kew staff are engaged There were also exhibits of plants of special interest to undergraduate students, who had come from most of the English and Welsh universities Among the subjects fully demonstrated several may be mentioned Thirty-nine genera of Coniferæ were represented by living plants, and a large series of rhododendrons in flower showed the range of structure in this genus The vegetation of South Africa, of British Somaliland, of high mountains, of Kangaroo Island (South Australia) and of the Andes indicated the connexions between systematics and ecology, as did also the germination of hundred-year old seeds, a large series of tropical megaphyllous plants and a fine display of dispersal mechanisms in grasses Diverse evolutionary aspects included a most instructive series of variations of the central theme of a legume, leaf-shape in species and hybrids, variation in species of *Dianthus* and *Tulipa*, the inflorescence of *Carex*, and parallelism in Fungi The morphological basis of much taxonomy was illustrated with reference to ferns, bladderworts, parasitic flowering plants, *Monadenium*, heteranthy in orchids, the procedure in formal taxonomy, and bad collecting The importance of anatomical and biochemical aspects of plant taxonomy were demonstrated by reference to *Strophanthus*, wood structure, and the vegetative structure of flowering plants The taxonomic basis of economic botany was shown with regard to wild cereals of Iraq, fence or barrier plants in warm climates, and the use of seaweeds in industry Large series of living specimens of plants of special interest attracted much attention Paintings and drawings showed the importance of the work of the botanical artist Series of recently published books on several subjects were on view An unusual exhibit was that of samples of newspapers from all parts of the world that had been used in forwarding plant specimens to Kew

Classification of the Coli-Aerogenes Bacteria

In 1949 a joint Sub-Committee of the Society for General Microbiology and the Society for Applied Bacteriology issued a report on the term coliform' (see *Nature*, **163**, 394, 1949), hitherto used by medical, veterinary, agricultural and water bacteriologists to describe organisms which are of interest to them for different reasons and have thus been classified in different ways The essence of the report was that the word should not be used as a noun, that it describes organisms resembling *Bacterium coli* morphologically and tinctorially but not necessarily in cultural and biochemical behaviour, and that it should not be used for defining any particular group Later, the Society for Applied Bacteriology, feeling that it was of great importance that workers should be able to recognize readily organisms described by those working in other fields, set up a sub-committee to examine the methods of classification of non-sporing, Gram-negative rods producing acid and gas from lactose, in the hope that uniformity might be established Its recommendation is that these organisms, comprising the 'coli-aerogenes' bacteria, should be classified into six basic groups according to their behaviour in the indole, methyl-red, Voges–Proskauer and citrate-utilization tests, and that further subdivision should be based on the temperature at which acid and gas are produced from lactose, and the ability to liquefy gelatin and pectin The nine species thus recognized are *Bact coli* types I and II, Intermediate types I and II, *Bact aerogenes* types I and II, *Bact coli* type I 44° C negative, *Bact cloacæ* and *Bact carotovorum* The eight so-called irregular types appearing in earlier classifications have been eliminated The report (obtainable from the General Secretary, Society of General Microbiology, 35 Villiers Road, Southall, Middlesex), which contains details of the preparation of the culture media and methods of performing the tests, will be welcomed by workers in the relevant fields, but it is recognized that additional tests may be necessary in certain forms of research and that more information is required on some aspects of the problem

Liquid Metals

The United States Atomic Energy Commission and the Department of the Navy have jointly issued a "Liquid-Metals Handbook" (pp 188, Washington, D C Govt Printing Office, 1950, 1 25 dollars) dealing with the uses and properties of the lower melting-point, liquid metals Although these may be used as coolants in nuclear chain reactors producing power, they already have, or may in the future have, spheres of utility in very many other directions The information here collected is therefore of direct interest to the chemist, the engineer, the metallurgist and the physicist In the first chapter the industrial utilization of liquid metals is considered at length, particularly in connexion with heat-transfer, and uses are mentioned which range from the already established practice of cooling valves in aircraft engines with liquid sodium, to their employment for reheating steam in turbine plant, the pasteurization of milk or in the preheating of the air for blast furnaces Chapter 2 is concerned with the physical properties of liquid metals with melting points up to that of aluminium, of two sodium–potassium alloys, and of the ternary lead–tin–bismuth eutectic. A large amount of data of value in many branches of science is included. The chemical properties and laboratory techniques, the resistance of materials to attack by liquid metals, heat-transfer and the large-scale handling of such liquids are then discussed. Each section is concluded by a most valuable bibliography This is a unique and very stimulating publication

Physical Society Summer Meeting in Belfast

The Summer Meeting of the Physical Society will be held in the Department of Physics, Queen's University, Belfast, Northern Ireland, during July 5–7, 1951, and is being organized under the auspices of Prof K G Emeléus It will be divided into three sessions, devoted to (1) textile physics, (2) gas discharges and spectra, and (3) cosmic rays On July 5 there will be a visit to the Linen Industry Research Association at Lambeg, and on July 7 it is hoped to include a trip to the Giants' Causeway Application forms, which can be obtained from the offices of the Physical Society, should be returned to Miss J Thompson, Physics Department, Queen's University, Belfast, Northern Ireland, not later than June 6 Applicants will require passports or travel permits

Joint Engineering Conference in London

On the occasion this year of the Festival of Britain, a Joint Engineering Conference will be held in London at the Institutions of Civil, Mechanical and Electrical Engineers, during June 4–15, the main purpose of which will be to record the contributions to the advancement of civilization made by engineers and scientific workers in Great Britain during the past hundred years In addition, it is hoped that distinguished foreign engineers will participate and outline how the contributions from their own countries fit into the general pattern The interdependence of all branches of engineering and the ever-growing co-operation of the members of the three major engineering Institutions in Great Britain will be emphasized, and the Conference will be open to all members of the three Institutions and to members of the institutions and societies participating in the Conference of Commonwealth Engineering Institutions and the Conference of the Engineering Societies of Western Europe and the United States of America Besides formal sessions, there will be a fairly wide choice of excursions and other social functions The proceedings of the Conference will be published in eleven separate parts, as follows (1) formal proceedings at the opening and closing sessions, and general summary of the Conference, (2) railways, (3) sea transport, (4) power, (5) aviation, (6) engineering education and practical training, (7) road transport, (8) telecommunications, (9) public health in municipal engineering, water supply and sewerage, (10) gas industry plant, mining and steelworks plant, (11) electrical measurements, television, cables, lighting and mining Further details can be obtained from the Secretariat of the Conference at the Institution of Civil Engineers, Great George Street, London, S W 1

Ray Society . Annual General Meeting

THE one hundred and sixth annual general meeting of the Ray Society was held on March 29 Two books, "Tunicata", by Prof N J Berrill, and "British Water Beetles", by Prof Frank Balfour-Browne, were published and distributed during the past year, it was announced that the first volume of "British Spiders", by G H Locket and A F Millidge, is about due for distribution, and that "British Mysidacea", by the late Prof W M Tattersall, will follow soon after this Progress was reported on the volumes "Watsonian Vice-counties", by J E Dandy and E W B H Milne-Redhead, and "British Sponges", by Dr Maurice Burton Officers of the Society were elected as follows *President*, Lieut-Colonel R B Seymour Sewell, *Vice-Presidents*, Dr John Hutchinson and Dr Errol White, *Honorary Treasurer*, Lieut-Colonel W P C Tenison, *Foreign Secretary*, Arthur Exell, *Honorary Secretary*, Dr Maurice Burton, *New Members of Council*, Dr W S Bristowe, Captain Cyril Diver, Dr L Harrison Matthews and N D Riley

Announcements

DR J D MOUNFIELD, at present head of the research department of the British Arkady Co, Ltd, Manchester, has recently been appointed principal of the National College of Food Technology Dr Mounfield, who is a graduate of the University of Manchester, has worked in the past for the British Flour Millers Research Association, and during the Second World War he carried out research for the Ministry of Food into the drying and storage of grain

DR A L RAE has been appointed to the newly created chair of sheep husbandry at Massey Agricultural College, Palmerston North, New Zealand Dr Rae has recently completed graduate study under Dr Jay L Lush at the Iowa State College, United States, followed by a tour of the animal breeding institutions in the United Kingdom He has concerned himself with sheep breeding problems and especially the statistical treatment of non-numerical data

THE Royal Dutch-Shell Group of oil companies is offering a research studentship in geophysics, of value £400 a year, which is open to men of any nationality less than twenty-seven years of age on October 1 The studentship is tenable at the University of Cambridge, initially for two years, but it may be renewed for a third year Further details and application forms (to be returned by July 1) can be obtained from B C Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge

THE Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1951–June 1952 Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr N B Marshall, British Museum (Natural History), London, S W 7, before the end of May

A SYMPOSIUM on "Recent Developments and Techniques in the Maintenance of Standards" will be held at the National Physical Laboratory, Teddington, during May 21–22 The standards to be discussed are those of primary loads, length, radioactive isotopes, temperature, luminance and frequency, two formal papers will be given on each of these topics Invitations to the symposium have been sent to various standards organizations, and the attendance will be fully representative of European and North American countries, as well as several members of the British Commonwealth The proceedings are to be published in due course

BY the courtesy of His Grace the Duke of Bedford the grounds of Woburn Park, Beds, are to be open to the public during the week May 28–June 2 (11 a m –5 p m), under the guidance of the Fauna Preservation Society The Woburn Estate comprises about 4,300 acres of woodland and 17,000 acres of agricultural land The collection of foreign mammals and birds in Woburn Park was started by the eleventh Duke about the year 1895 Of the species of deer which can be seen, the most interesting is Père David's Deer, which form the only herd in existence, since the animal is now extinct in its native China Admission charges to the Park will be adults, 2*s* 6*d*, children, 1*s* Further details can be obtained from the Secretary of the Fauna Preservation Society, c/o Zoological Society of London, Regent's Park, London, N W 8

IN *Nature* of February 18, 1950 (p 264), it was stated that the *Chemische Zentralblatt* had been issued in a combined form, the editor, Dr M Pflucke, informs us that the journal is published jointly by Akademie-Verlag, Berlin, and Verlag Chemie, Weinheim

L'Astronomie for January 1951 contains a number of interesting items, the first of which gives a short description of the photography of nebulæ in monochromatic light (Hα), and the cover bears a photograph taken on November 6, 1950, at the Observatory of Haute-Provence On p 1 there is a photograph of the instrumental equipment in use at the Observatory The eighth and last of the series of articles on the construction of an amateur's telescope appears, in which a note of warning is given at the end while a 20-cm reflector with accessories may be relatively simple to construct, considerable difficulties may be encountered in attempting to make a 30-cm telescope A short description of the appearance of the blue sun and moon, seen in various countries during September 26–28, 1950, is given, but, strange to say, the author professes to be ignorant of the cause of the phenomenon The explanation is, of course, well known to meteorologists, and the phenomenon is fairly common in countries where a large amount of fine dust is liable to be carried into the upper regions of the atmosphere.

COUNCIL FOR THE PROMOTION OF FIELD STUDIES

3. DALE FORT FIELD CENTRE

By J. H. BARRETT
Warden

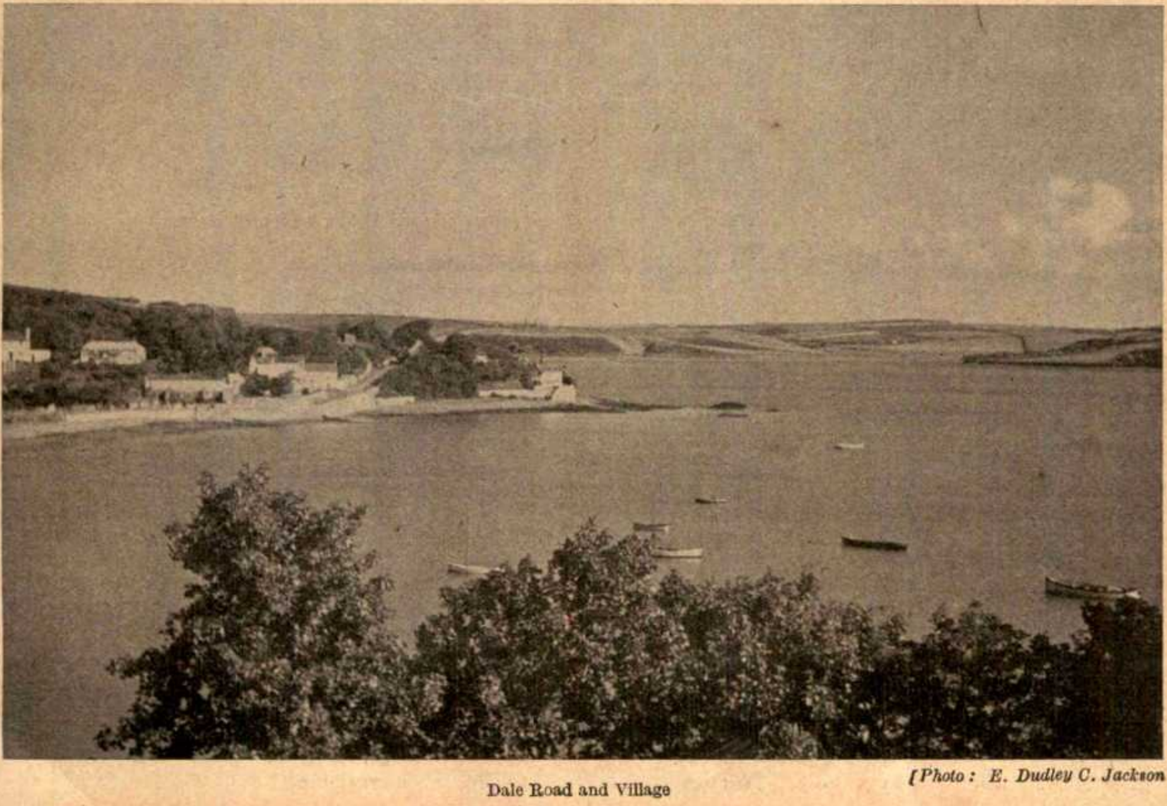
DALE FORT stands on the tip of a promontory overlooking the waters of Milford Haven in Pembrokeshire. When establishing its series of field centres, the Council for the Promotion of Field Studies carefully selected sites in a wide variety of regions. At Dale Fort there are facilities for all those studies based on a coast. Within three miles of the Centre are beaches of every degree of exposure, from sheer cliffs pounded by Atlantic gales, through rocky coves and sheltered bays to the shingle and mud of the flats where the Gann stream goes quietly down to the sea. Inevitably marine biology bulks larger in the life of the Fort than anything else, although the geographical interest of the county presents a challenge to the geographer as clearly as the coastline does to the zoological and botanical research worker.

Perhaps the only danger inherent in the superb site of the Fort is that the work of the Centre might tend to become too specialized. While making the most of its local opportunities, the Centre must always welcome workers in any subject, for the Council's scheme includes historians, artists and archæologists as well as zoologists and botanists. No week is more stimulating than when artists, specialist research workers, amateurs and school parties are there together, all doing different things and each contributing some point of view in discussions that is fresh to the others. Any idea that the amateur naturalist is not welcomed would be dismissed if the doubter had once seen how important to a Centre is the enthusiasm of an amateur for his chosen study.

Skokholm Bird Observatory is an integral part of the Centre. For four years an ecological survey has been in progress. An island of only 250 acres has peculiar advantages for this type of research work. The primary botanical maps are complete. Detailed analysis of the composition of certain fresh- and salt-water communities is progressing. Micro-climate stations are maintained. A mass of information on the distribution and population changes of many animals has been accumulated. Research workers will find much background information readily available. Amateur naturalists who visit the Observatory, in numbers, learn how much more interesting their subject becomes as soon as a plan of work is defined and developed. No teaching is organized on the island; this is the responsibility of the main centre at Dale Fort.

More than a thousand students visit each of the Council's field centres every year, a student being defined as anybody wishing to know more of the subject that already interests him. A larger number go to Dale to learn about the intertidal fauna and flora than are accommodated in any other marine station in Britain; they are mostly undergraduates and from school sixth forms.

The unique diversity of animal life on the seashore is well known. The intensity of the struggle



Dale Road and Village

[Photo: E. Dudley C. Jackson

for existence is increased by the hazards of an inter-tidal life. Many different solutions to the problems have been evolved. The minutely delicate adaptations, the mechanisms of efficiency, the puzzling and beautiful arrangements within a natural community frequently stir students to curiosity and so lead them to the unique pleasures of discovery. Only in a few cases can schools succeed in teaching discrimination. It is a sad result of the present formal educational system that, if left to themselves, most of those from school sixth forms pay more regard to words and diagrams written on a blackboard than to the evidence of their own senses. The marine biology courses at Dale require students to observe critically for themselves, to record accurately and to interpret honestly—and quite incidentally something is learnt that is useful when facing examiners.

The same principles underlie all the courses. Geographers are sent about the peninsula to collect geographical information. Journeys include frequent stops to inspect particular features. The whole week is designed, however, as something more than an unco-ordinated series of simple exercises. The attempt is made to integrate the effects of geology, of meteorology and of man upon the natural scene; to show how man, like any other animal, has adapted himself to his surroundings, and how an unbroken thread of continuity binds the details of the landscape together and so imposes a pattern on the life of man himself. In seeing this for themselves, the sixth formers have suddenly progressed from the uncritical and automatic digestion of facts presented in tidy parcels during 45-minute lessons to an understanding of the real meaning of learning lessons at all. "In understanding is our only emancipation." Hundreds of undergraduates and sixth form students take their first critical look at anything while among the Dale seaweeds or puzzling over some detail in the Pembrokeshire landscape. At Dale there is no formal presentation of factual information. Each student must make the discovery for himself. Help is always available, but the short cut for the faint-hearted is never provided; the more that is asked the more is given. The Council's centres are by no means another patent aid to the passing of examinations.

The small staff at the Centre is kept busy. Forty-five students are in residence at one time, and the warden and assistant warden share the teaching between them. Not only do they have to understand, but also they must be able to transmit understanding. Their scope is limited only by their ability to acquire knowledge in subjects far outside their training. The nature of the work forces them to take a very wide view, with the underlying danger that they may become jacks of all trades and masters of none. A Centre cannot function properly without the assistance of specialists. Any teaching establishment suffers if no research work is in progress within it. The teacher who has ceased to learn has probably also lost his interest in teaching. The Centre's staff is saved from this calamity by all that goes on around them. Whether they want to or not, they must go on finding out things, if only to answer the questions from students who are interested in the zonation of gastropods, cold fronts, microliths or the breeding behaviour of redshanks. Increasing their general knowledge of the region will, for several years, absorb what little time might otherwise have been available for research in their own subject. It is not anticipated that, however skilfully they may be directed, quite inexperienced students in residence for only a week can ever produce results of scientific value. To a great extent it is left to pure research workers who use the Centres to contribute not only their attitude to a problem (which is an important contribution) but also the results to the Centres' store of local knowledge.

The original plans of the Council were that many of the parties visiting its centres would have leaders responsible for the programme of work. Experience at Dale is that very few teachers are prepared to teach their own sixth form in the field the most rudimentary natural history. With their large classes and tight schedules of work to be got through, they in general find it hard to acquire the knowledge that can only be got from looking at Nature in the field. The Centre, in fact, has to teach the teachers, and at Dale special courses are given each year to demonstrate the simple techniques involved. Some training colleges now include in the syllabus a week at Dale as a proper complement to the work done in laboratory and library. The influence of the Centre is spread very widely in this way, and the responsibilities are correspondingly great. Quite apart from the course itself, these various kinds of people gain something from being for a week in a building on the edge of the sea and far from the smoke of chimneys.

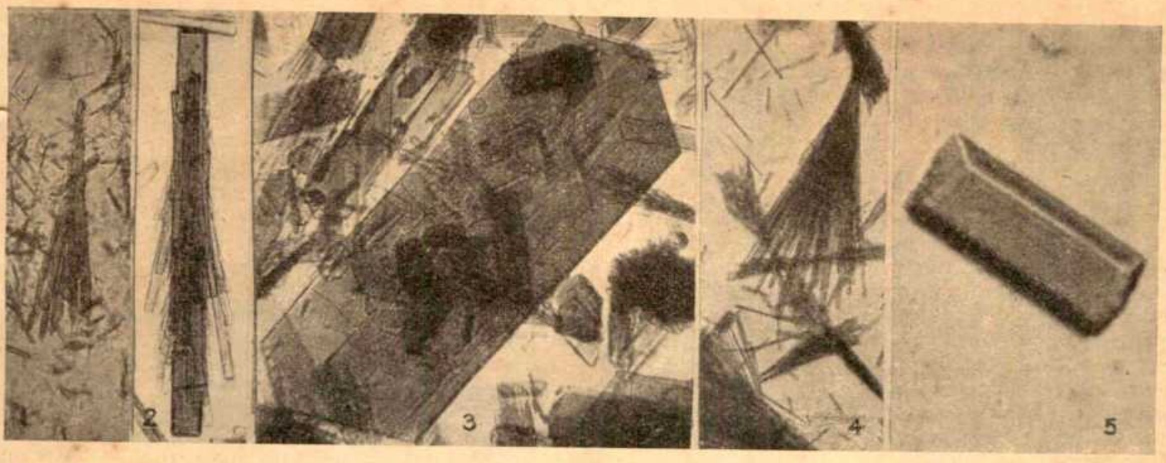
Most of the students are themselves quite strange to rural natural surroundings. Perhaps ten per cent of those still at school have never spent a night away from a town before they come to Dale, and find it difficult to realize that the inhabitants of a remote village are not only content but actually prefer their village to the so-called amenities of the towns. This realization cannot be allowed for on the Centre's programme; but it represents an important part of the work. For seven days students' movements are controlled by tides and not by a watch. They are living amid natural beauty. Slowly they become aware that the whole scene is greater than the sum of its parts. Whenever possible, discussions, teaching and demonstrations at Dale are attempts to shine a light upon the great mystery and unity of Nature. In doing so, certain details stand out clearly and are understood. The schoolboy feels less strange, less lost in what is really his natural habitat; just occasionally the reward is to see a boy transformed.

CRYSTALLINE FORMS OF MYOGLOBIN FROM HORSE HEART

By R. A. LAWRIE

Low Temperature Station for Research in Biochemistry and Biophysics, Cambridge

THE small molecular size of muscle hæmoglobin[1], presumably indicating correspondingly simple structure, makes this protein particularly attractive for analysis by X-ray crystallography[2]. Nevertheless, although myoglobin was first crystallized in 1932 (by dialysis against ammonium sulphate), the only habit reported for some years was that of thin needles, occurring in 'wheat-sheaf' bundles[3]. In 1942, however, crystals of beef myoglobin as minute, triangular 'plates' were obtained from this medium[4]. Although Rees[5] discovered later that large, relatively wide, 'plate'-like crystals could be obtained by permitting crystallization from a concentrated phosphate buffer, these were still very thin. The long exposures to the



Crystals of myoglobin. 1, Ammonium sulphate, 3 days; 2, ammonium sulphate, 6–8 weeks; 3, phosphate buffer, 36 hr.; 4, phosphate buffer, 12 hr.; 5, phosphate buffer, 4 weeks. 1–4, × c. 100; 5, × c. 170

X-ray beam which were consequently necessary to secure a reasonable diffraction photograph appeared to damage them and limited the information they provided[2]. It has thus been of interest to study the various crystalline habits of the protein and to attempt the production of crystals in which thickness is of the same order as length and breadth. Some findings in the course of this work are presented here.

Myoglobin (with residual hæmoglobin) was isolated from horse heart by the method of Theorell[3,6], as a clear, deep-red solution. Ammonium sulphate was added to saturation, causing precipitation of mixed amorphous myoglobin and hæmoglobin. This process was permitted to continue for not longer than two hours, at 0° C., after which the precipitated pigments were swiftly separated off by suction filtration. (Prolonged standing in contact with ammonium sulphate, at this stage, produces a microcrystalline material which is difficult to re-dissolve.) The brown solid was transferred to a mortar, in an ice-bath, and extracted by 4*M* phosphate buffer (*p*H 6·8 : 312 gm. $NaH_2PO_4.2H_2O$ + 348 gm. K_2HPO_4 per litre). The extraction was carried out at 0° C. to minimize denaturation and to aid solubility, myoglobin being less soluble at room temperature. Hæmoglobin, unlike myoglobin, is practically insoluble in concentrated phosphate buffer[7], and may be removed by gravity filtration of the extract. Saturation of the latter with ammonium sulphate (after dialysis against distilled water, in the cold, until freed from phosphate) produced an amorphous precipitate, consisting, almost entirely, of brown metmyoglobin. From this point, procedure depends on the type of crystal desired.

(*a*) *Crystallization from Ammonium Sulphate.* The 'wheat-sheaf' aggregates of needles (see Fig. 1), which seem to be frequently associated[2–4] with myoglobin crystallized from this medium, may readily be produced by dissolving solid metmyoglobin, prepared as above, in a minimal quantity of distilled water and adding ammonium sulphate to about 4*M* concentration. The solution is left at room temperature (18° C.) for two to three days. Prolongation of the time of crystallization, by making the initial water solution of the pigment more dilute, and keeping the material at 0° C., after addition of ammonium sulphate to 4*M* concentration, results in the formation of large rosettes of needles, having an overall diameter of about 5 mm.

Both plate and prism forms of crystal were also obtained from this medium. A solution of metmyoglobin in water was reduced with sodium hydrosulphite, and a stream of carbon monoxide passed through. The resulting carbon monoxide – myoglobin solution was dialysed against saturated ammonium sulphate in an atmosphere of carbon monoxide for three days at 0° C. Insoluble debris was centrifuged off and the clear solution set aside for three to four weeks at 0° C., when 'plate' crystals of carbon monoxide – myoglobin were obtained. These appeared in the form of regular hexagons, but their true habit has not as yet been confirmed. (Keilin and Schmid have reported similar crystals from whale myoglobin[8].) These crystals were kept for a further three to four weeks at 0° C., transforming into prisms of considerable thickness; these occurred in clusters, however (Fig. 2).

(*b*) *Crystallization from Phosphate Buffer.* Typical plate-crystals, in the form of irregular hexagons, such as those described by Rees[5], are easily obtained by saturating a quantity of 4*M* phosphate buffer, at 0° C., with freshly precipitated, amorphous metmyoglobin: insoluble material is filtered off, one-third of its volume of distilled water is added, and the solution is left at 0° C. for one to two days (Fig. 3). When a buffer of *p*H 6·2–6·4 was employed, the plates obtained were rectangular, some individuals having an 'incomplete' corner, not unlike the crystal of cholesterol. If, however, crystallization from the phosphate medium is speeded up by allowing a saturated (0° C.) solution of metmyoglobin in 4*M* phosphate to stand at room temperature, there appear, in 12 hr., sheaves and rosettes of needles, exactly corresponding to those obtained from ammonium sulphate after two days (Fig. 4). On the other hand, just as prolongation of crystallization time from ammonium sulphate eventually yielded crystals having an appreciable depth, so, too, crystallization from phosphate buffer, after four weeks, produced 'solid' forms. This occurred, on several occasions, merely by keeping the plate-form crystals at 0° C.

At other times, and also at 0° C., when the initial concentrated solution of metmyoglobin was kept absolutely still, on a shock-absorbent mat, 'solid' crystals appeared without the previous production of the plate form. These crystals grew as separate cuboids, exhibiting no tendency to aggregate (Fig. 5).

and thus differing from the sheaves of elongated prisms described by Drabkin[9]. The nature of the medium—phosphate buffer or ammonium sulphate—appears, therefore, to be less critical than has hitherto been supposed; needles, plates and prisms may be obtained from either, the predominant factor being the speed at which crystallization is allowed to proceed.

It was desirable to standardize the conditions yielding 'solid' forms of metmyoglobin crystals. Moreover, it appeared that slight fluctuations in the environmental temperature were responsible on the occasions when the most satisfactory prisms were secured. To accentuate this effect, a small hollow vessel, of high thermal capacity, was constructed and placed in a room kept constant at 0° C. Heating coils beneath the vessel were connected to mains electricity supply through a mercury switch, the latter controlled by a clockwork motor driving an eccentric cam, and so arranged that the circuit was complete or broken for periods of 13 hr. alternately. The apparatus was adjusted to give a repetitive variation in temperature from 0° C. to 20° C. It has been found that solutions of freshly prepared and precipitated metmyoglobin, in $3M$ phosphate (pH 6·8 : 234 gm. $NaH_2PO_4.2H_2O$ + 261 gm. K_2HPO_4 per litre), of concentration 5–10 mgm. metmyoglobin per ml., if kept absolutely free from vibration within the vessel described, will produce a cuboidal (or rhomboidal) prism habit of crystal in three to four weeks. Concentrations greater or less than those in the range given are apparently not so satisfactory, under the conditions described, for producing 'solid' forms. From the points of view of shape, and of the absence of aggregation, such crystals are suitable for X-ray analysis, but they are inclined to be small. Further work, designed to increase their size, is continuing.

I wish to thank Prof. D. Keilin for his advice and encouragement. I am also grateful to Mr. D. P. Gatherum, of the Low Temperature Research Station, for the photomicrography and to Mr. A. Snow for constructing the crystallization vessel.

This work was carried out as part of the joint programme of the Food Investigation Organization of the Department of Scientific and Industrial Research, and of the Scientific Adviser's Division, Ministry of Food. [Dec. 8.

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RADIO OBSERVATIONS OF THE AURORA ON NOVEMBER 19, 1949

By N. C. GERSON

Geophysical Research Directorate, AF Cambridge Research Laboratories, Cambridge 39, Massachusetts

A PHENOMENON long known to the radio amateurs was observed on November 19, 1949, over the north-central and north-east portions of the United States and over the adjacent regions of the Dominion of Canada.

This phenomenon, which may be termed 'auroral interaction', generally describes the reception of radio signals at a given location from a northerly direction, even though the transmitting station may lie to the east, west or even south of the receiver. In many instances, the transmitting and receiving stations which are able to establish radio communication through auroral interaction are located geographically so that they cannot communicate with each other during normal ionospheric conditions. During periods when visible aurora is present, however, these stations may establish contact with each other by means of auroral interaction only when the directional antennæ at both locations are directed 'northwards'.

The radio signals received when the waves are returned from the north are characterized by several distinct features. Usually the received signal is modulated both markedly and rapidly. Also, the constant and variable fading which accompanies this type of radio contact is sufficient to discourage the use of radiotelephone during the period when communication is possible. Thus, to maintain (auroral) radio contact between the two stations concerned, it is often necessary to employ continuous wave transmission. In any event, either when utilizing radiotelephone or continuous wave emissions, the received signal has a characteristic flutter and tone which seems to be typical of auroral interaction.

Through an examination of reports of auroral interaction, it seems possible to describe the existence and the spatial extent of a polar aurora even during periods when the sky is obscured. An example of the method is described below. These data were obtained during the period 2355 Greenwich Mean Time, November 19, 1949, to 0145 G.M.T., November 20, 1949. In this time interval, more than fifty-two reports of auroral interaction were made by thirty-seven radio amateurs in twenty-one different localities in the United States and the Dominion of Canada. The operating frequency at which the radio contact was established was about 50 Mc./s. The observational material is plotted in the accompanying diagram, where each line connects the location of the two amateur stations which established communication by means of auroral interaction.

In analysing the observations, it was assumed that the portion of an aurora which has the greatest light intensity was also that portion which allowed auroral interaction to take place. By far the most commonly found altitudes of the lower 'edge' of the aurora borealis is 100 km.[1], and the maximum light intensity in the case of arcs, draperies and drapery-shaped arcs is 5–10 km. above the lower edge[2,3]. Thus, the region causing auroral interaction was considered to lie in the altitude range 100–110 km. above the earth's surface. Under these conditions, it becomes possible to delineate the geographical extent of the auroral projection.

With an altitude range of 100–110 km. as the auroral reflexion region, the extreme southern border of the aurora is limited to a distance of about 1,150 km. from the southernmost stations. This distance allows the tangent ray from the southernmost transmitter to be returned from the aurora. As some stations in radio contact with the most southerly station were located several hundred kilometres to the north, it may be concluded that the angle between the auroral reflexion surface and the tangent ray was acute.

In reducing the observations, ray paths were drawn to a reflecting surface lying just within the tangent

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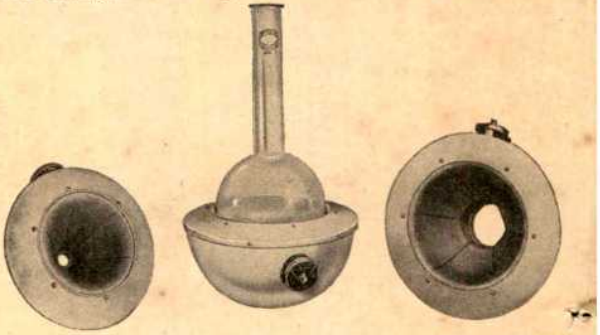

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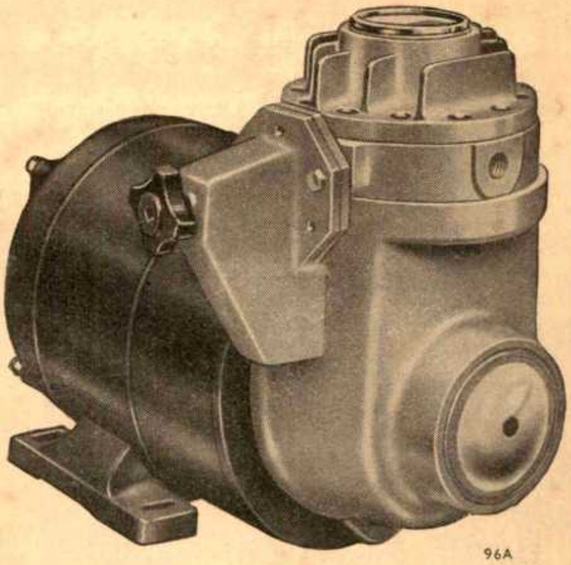

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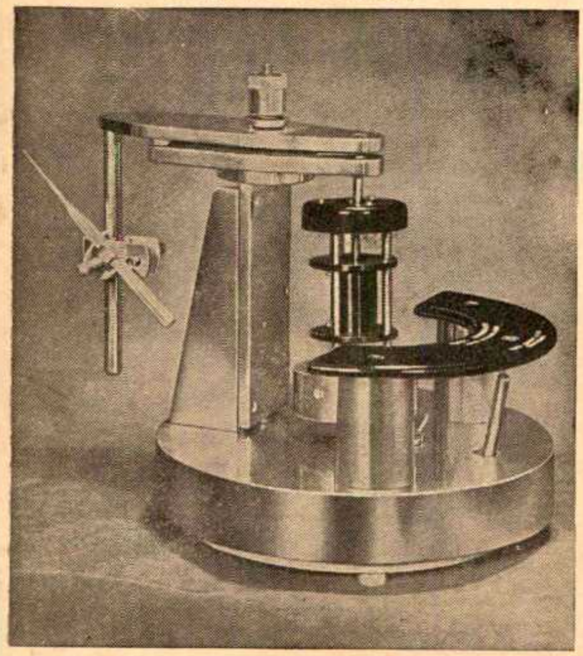

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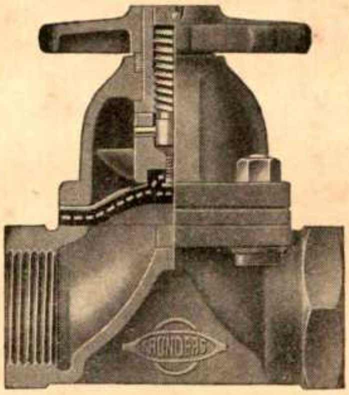

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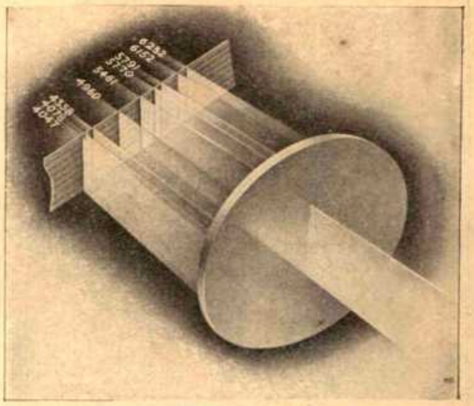

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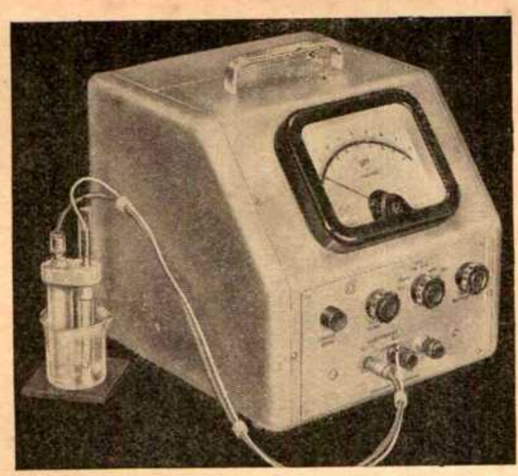

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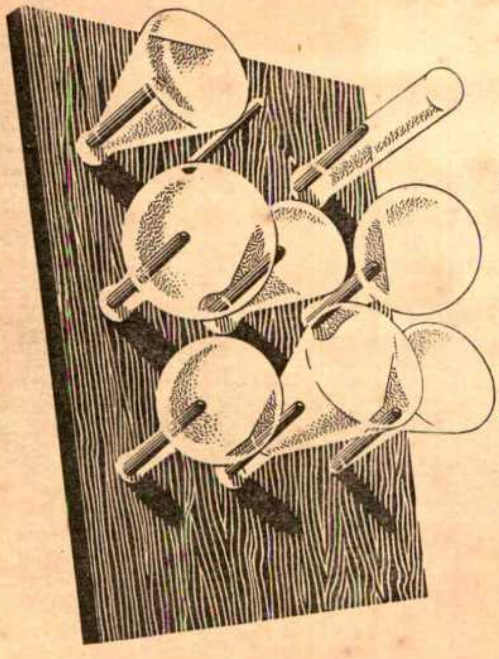

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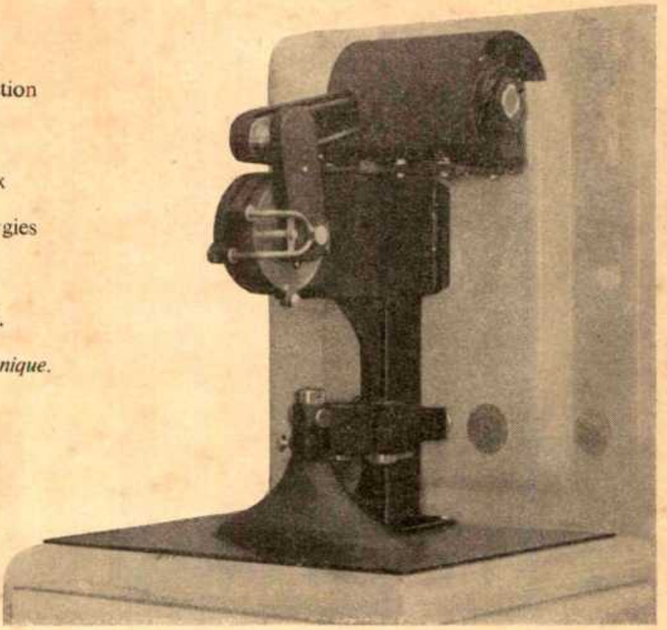

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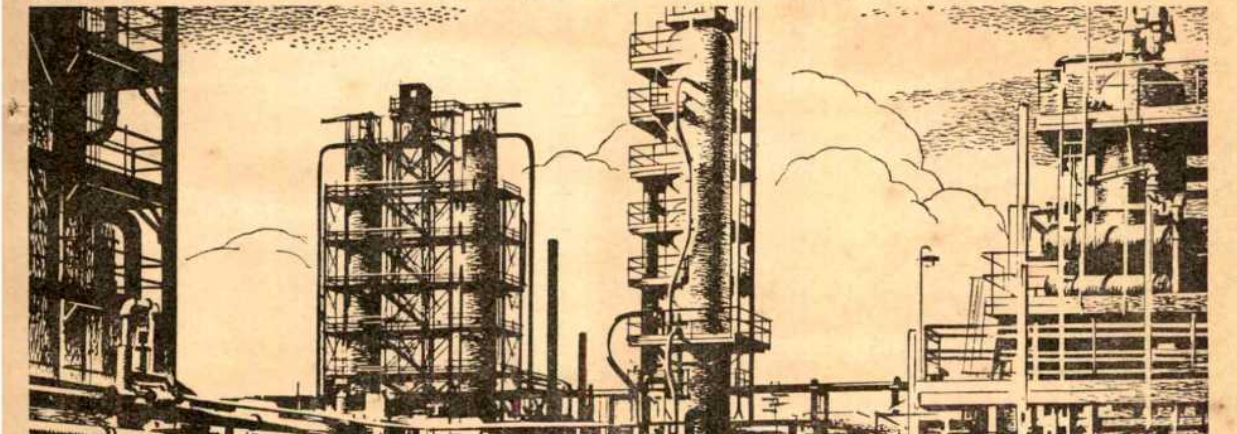

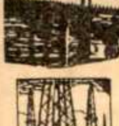

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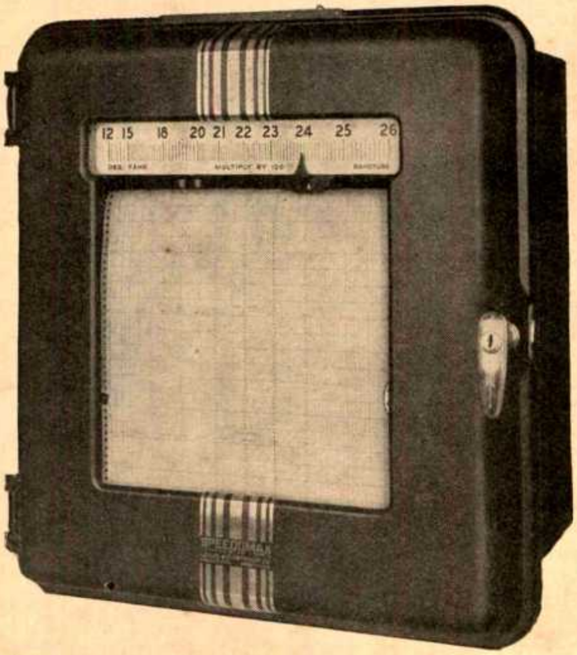

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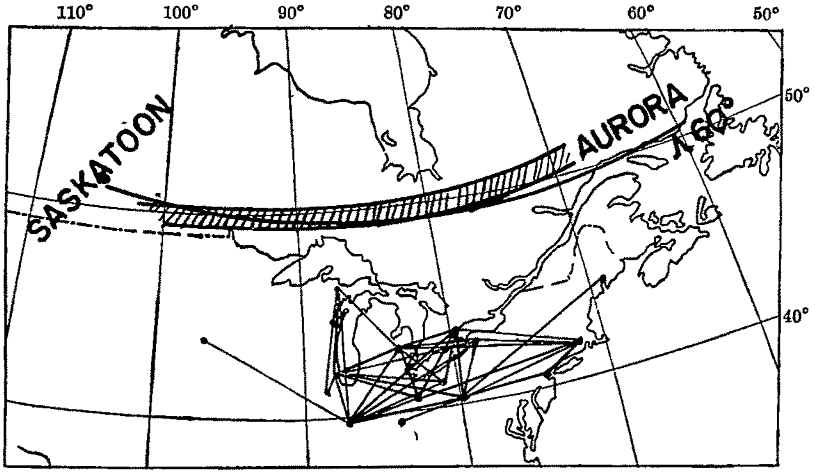

ray distance (of about 1,150 km) The first results examined were those involving the most southerly stations The position of the synthesized aurora obtained by this procedure is shown in the diagram It is unfortunate that no information is immediately available regarding the presence of visual aurora over the eastern part of Canada However, a report from Saskatoon, Saskatchewan, indicated that an aurora was observed "through the clouds" some time during the period when auroral interaction occurred

The large degree of modulation in the returned radio signal may perhaps be attributed to two causes (*a*) a variation in the ability of the ionized particles (either the bombarding particles or those produced by the bombarding particles) to reflect probing electromagnetic rays, and (*b*) a variation in the absorption properties of the atmospheric regions concerned, this absorption being brought about by energy transferred from the bombarding particles

Case (*a*) would arise if the density of the charged particles in the reflecting volume changed with time The simplest explanation would merely require that the charged particles passing through the reflexion volume should arrive in bursts or bunches, where the density of particles changed from burst to burst If the reflexion arises directly from the protons passing through this common 'beam volume' in varying numbers, the number density in the proton flow would be about 5×10^{10}/cm^3 On the other hand, the reflexion may arise from electrons, which would require a minimum number density of about 3×10^7/cm^3 It seems unlikely, however, that electrons of about 15 eV energy could penetrate to this depth in the atmosphere If reflexion occurs from electrons, it would appear more probable that the electrons were formed in the atmosphere by the bombarding particles (In this event, terrestrial mechanisms for producing the bunching may be considered) The rapid fading and flutter noted on the reflected signals would be expected to be most pronounced on frequencies close to the critical or penetration frequency, these are most sensitive to changes in the density of the charged particles causing reflexions

With respect to case (*b*), it seems clear that if the velocity of the bombarding particles is reduced to zero, a good proportion of the kinetic energy of the particles will be dissipated as heat The resulting rise in temperature of the atmospheric particles may then be sufficient to produce a noticeable absorption effect

If it is assumed that the incoming particles, having a velocity of about 3×10^8 cm/sec, are protons, and if 10^{11} protons are absorbed per second in the altitude range 100–110 km (where the average atmospheric number density is about 10^{13}/cm^3), the average increase in temperature per particle is only about 2–3° K/sec Of course, high density bursts of short duration may raise this figure appreciably over short intervals of time In general, however, it would seem that the heating effect (which may be somewhat high over a small volume) would be dissipated rapidly by means of the general winds and turbulence existing near the 100-km level While the time variation in radio wave absorption is undoubtedly inherent in the observed 'garbling', it appears probable that individual bursts of absorption would be smoothed into a general rise in the absorption properties of the atmosphere Thus, it would also appear that the main effect in producing the rapid variation or flutter of the returned radio waves would arise from (*a*) the rapid variation in number density of the incoming particles, rather than from (*b*) the variation in absorption which these particles produce in the atmosphere

The procedure described above suffers from several limitations First, as in any co-operative venture, it cannot be stated with certainty that all possible reports of auroral interaction have been either observed or reported Undoubtedly, there were a sufficient number of radio amateurs 'on the air' (at localities to the south of those indicated in the diagram) to have utilized auroral interaction in establishing radio contact with other stations had it been possible to do so However, no reports have been received indicating that an unsuccessful attempt had been made to establish radio contact through auroral interaction Secondly, the assumption that the aurora is located just within the tangent ray distance from the southernmost reporting stations is open to some doubt

It is interesting to note that the basic technique underlying this study of the aurora may be refined considerably so as to provide a new tool for auroral observations The experimental method may be employed for the detection of the aurora when visual observations are difficult because of bright moonlight, scattered light or general cloudiness The antenna beam-width employed by the amateurs is about 30–35°, making it difficult to determine accurately the azimuth of any particular radio ray received from the aurora, however, narrower beam-widths undoubtedly could be employed to provide much greater accuracies It would also be expected that analyses of the rates and character of the garbling and fading of the returned signals would provide valuable information on the mass and velocities of the bombarding particles [Dec 19

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[1] Vegard, L, and Krogness, O, *Geofys Pub*, 1, No 1 (1920)

[2] Stormer, C, *Terr Mag Atmos Elec*, **51**, 501 (1946)

[3] Stormer, C, *Terr Mag Atmos Elec*, **53**, 251 (1948)

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

ANNUAL GENERAL MEETING AND THIRD RESEARCH PANEL MEETING

THE second annual general meeting of the British Gelatine and Glue Research Association was held at the Waldorf Hotel, London, W C 1, on February 7 The director of research, A G Ward, in presenting the Council's report*, gave an account of the organization which had been established During the past year the laboratory premises have been acquired at 2/4 Dalmeny Avenue, Holloway, London, N 7 , these premises were previously occupied by the British Food Manufacturing Industries' Research Association, and they have been adapted and equipped to the needs of the British Gelatine and Glue Research Association There are now separate laboratories for general chemistry, bacteriology, chromatography, physical chemistry, physics, constant-temperature work, and technical work, together with three rooms for balances, autoclaving and stores, respectively , in addition, there are the usual technicians' workshops, reading room and library, and clerical offices The staff consists at present of one senior research officer and three officers, who with the director of research will carry out the programme of fundamental research, and one senior research officer has been appointed to look after the more technical work A bacteriologist, who will also undertake independent work, an instrument mechanic, research assistants and secretarial staff bring the total number to fourteen

The immediate objective of the research programme is the study of the structure and physical properties of gelatine Being the product of the degradation of collagen, gelatine is not a homogeneous substance, and it is necessary in determining its structure to measure the distribution of molecular weights and sizes, as well as the chemical composition , the nature of the degradation process is also a problem of importance This, then, is the fundamental research that is being undertaken in conjunction with the short-term work, which is mainly of a practical and empirical nature In addition, the Association has been issuing two quarterly publications the first, the "Bulletin", reports on activities of the Association and the industry, and is a medium for publishing small items of research , the other, "Abstracts", reviews all relevant literature relating to the gelatine and glue industry

The third research panel meeting of the Association was held at Beale's Restaurant, Holloway Road, London, N 7, on February 8 In addition to representatives of member firms, there were numerous visitors, including Prof F J W Roughton and B G. McLellan, and representatives of government laboratories and of other research associations Members of three of the research panels of the British Food Manufacturing Industries' Research Association were also present The chair was taken by the chairman of the British Gelatine and Glue Research Association, S G Hudson

first two meetings of the panel having been the consideration of the raw materials of glue manufacture and the properties and dy of these substances, the papers at this third meeting dealt with various aspects of the uses of gelatine and glue The session was opened by E H Moore, of Messrs A Adams and Co , Ltd , with a contribution entitled "The Use of Gelatine and Animal Glue in Industry" Mr Moore emphasized the importance of research into the uses of gelatine and glue, to be undertaken along with fundamental research so as to provide a balanced programme of work In addition, more is required to be done to see that the existing body of information on the uses of gelatine and glue is widely known and used Animal glues still have very widespread uses in, for example, the wood-working trades , but vigorous action is needed to see that they are not displaced by other materials, either through lack of publicity by the industry or by unnecessarily stringent specifications

The second paper, on "Some Special Problems Connected with the Use of Gelatine in Foodstuffs", was given by J W Selby, of the British Food Manufacturing Industries' Research Association The food manufacturing industries use some 7,500 tons of gelatine annually, and its simpler analytical characteristics are now defined by law The statutory instrument specifies upper limits for ash content, arsenic, heavy metals, etc , based on the assumption that gelatine seldom constitutes more than ten per cent of an article of food There is, however, the possibility that more stringent limits might be applied, and might be extended to include standards of bacteriological purity Turning to the physical properties of gelatine, Mr Selby stressed the great importance of high jelly strength It is also desirable that jelly strength should change as little as possible with the temperature of measurement Similarly, in many applications the melting and setting characteristics are important, but viscosity of solutions plays only a minor part Tendency to foam is a disadvantage in most applications

Mr G. F Glover, of the Wiggins Teape Group Research Organization, gave the last paper of the morning session, "Paper Sizing" Tub sizing is performed by running the paper through a bath of gelatine or glue solution before drying Its function is either to provide an ink-resistant surface and improve the surface resistance to abrasion, or to increase the dry or wet strength of the paper To secure application mainly in the surface layers, a solution of fairly high viscosity is needed This is frequently obtained by using a medium-viscosity gelatine or glue with the addition of alum Temperature control is also important When penetration through the paper is required in order to modify the bulk properties, higher temperatures, lower viscosities and more prolonged immersion are used It is common practice to prepare one week's supply of sizing solution at a time This involves degradation problems, although bacterial attack is effectively prevented by suitable preservatives

In the afternoon, R C M Smith, of Messrs Ilford, Ltd , read a paper on "Some Aspects of the Use of Gelatine in the Photographic Industry" Gelatine is unique in possessing a combination of properties which makes it suitable as a medium for the preparation of light-sensitive silver halide dispersions Its suspending power is one of the most important properties In this connexion, Mr Smith mentioned the work of Sheppard and his colleagues on the adsorption of gelatine to silver bromide The sol–gel transformation plays a great part in making possible some of the manipulations necessary in the prepara-

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d Glue Research Association Second Annual tober 1949 to September 1950 (from the a House, 52 Lincoln's Inn Fields, London, tion of modern film, and its mechanism is important to photographic manufacturers Processing and some stages of the manufacture are only possible because of the ease of diffusion of ions and molecules in the medium into and out of gelatine For special purposes, it is sometimes necessary either to harden or even insolubilize the gelatine, or to soften it, and gelatine can easily be modified in these ways Gelatine has a profound effect on the sensitivity of the emulsions, and much work has been carried out on this, but the mechanism of the action is still not completely understood It is desirable that the gelatine should be of uniform standard from batch to batch, particularly with respect to viscosity and sensitizing power.

CAUSATION AND EXPLANATION IN THEORETICAL BIOLOGY

IN a recent issue of the *British Journal for the Philosophy of Science* (1, No 4, February 1951), J S Wilkie considers some of the classical problems of explanation in biology in the light of a relative theory of causation A cause is taken to be some factor to which is attributed the disturbance of some regularity Living things are extremely complex systems in which the parts have causal relations *inter se* the regular rhythm of the heart is disturbed by nervous stimulation, the regularity of an undifferentiated field of competent ectoderm is disturbed by the presence of an optic vesicle near some part of the field But living things as relatively isolated systems can themselves be considered as complex regularities which are disturbed by environmental interference Reaction with the environment can be considered as constituting a causal event only if there is some assignable disturbance of some regularity of the system since the system is not totally isolated, it will have regular and constant relations with its environment which are necessary to its maintenance as a system, thus the entry of oxygen into the system cannot as such be considered as a causal relation with the environment On the other hand, episodic changes such as a temporary increase or diminution of oxygen in the immediate environment definitely disturb the rhythms of the organism and can thus be considered as causal Among such episodic causal events are the reactions of environmental changes with the sense-organs

Whatever can be deduced from the known properties of the system alone receives explanation, but not causal explanation

Mnemic phenomena introduce causal events of peculiar interest With respect to the organism they are causal, since there is nothing in the structure of the organism from which we can deduce the memories it acquires Whereas in reflex activity the organism behaves as an elastic system, in memorizing it behaves as an inelastic system Mnemic traces, considered as imposed upon the structure common to a species, are consequences of causal events and therefore causal themselves with respect to the specific regularity of the species But mnemic traces do not remain indifferent to one another, as do the traces left in the wood of a tree by wet and dry seasons, they become organized *inter se* Thus the behaviour of these traces has its own regularities which, since they are regularities, might be explained by a knowledge of the properties of the materials of the system (as cleavage patterns can be explained by molecular forces) This, however, appears improbable, since the physical language lacks the necessary concepts (constructs) under which the peculiar behaviour of mnemic traces could be subsumed Physical attractions all appear as functions of space and time, whereas mnemic attractions appear as functions of space, time and similarity

Wilkie also attempts to justify teleological explanations, but it is not considered appropriate to treat these as causal explanations

FORESTRY COMMISSION

ANNUAL REPORT FOR 1949

THE thirtieth annual report of the Forestry Commissioners covering the year ending September 30, 1949, has recently been published* Since the passing of the Forestry Bill in 1919, the Commission has published quinquennial reviews of the work done, in 1924, 1929 and 1934 The Second World War brought the gap to fifteen years, the present report being the first to be issued since the War ended

In the thirty years of its existence the Forestry Commission has acquired an area of 1,500,000 acres, of which 971,000 were classified at the time of acquisition as plantable In addition, 57,000 acres of standing woodland have been acquired. By the aid of planting grants, private owners planted 182,000 acres Planting operations were of necessity severely interrupted during the Second World War.

With regard to the plantations, which range from 1 to 30 years in age, there is a total of 550,624 acres, of which 515,666 are conifers and 34,958 hardwood trees The youngest ones, 1–5 years old, cover the largest area (123,483 acres), while the oldest, 26–30 years, the smallest (32,959 acres) These latter are now producing some revenue Furthermore, there is what the Commissioners term a by-product, namely, the establishment at a small cost of six national forest parks comprising 240,000 acres

Other minor Forestry Acts have been passed since 1919 the Act (Transfer of Woods) of 1923, which empowered the transfer of the majority of the existing Crown woods—for example, the New Forest, Forest of Dean—to the Commission, and in 1927 a short Act authorizing an increase in the number of Commissioners and empowering them to make by-laws with respect to their properties The issue in 1943 of a report by the Commissioners on post-war forest policy resulted in the Forestry Act of 1945 The Act brought into force ministerial responsibility for future forest policy, an action which was by then very justifiable The Minister for Agriculture and Fisheries was responsible for England and Wales, while Scotland came under the Secretary of State, the lands acquired since 1919 being invested under the appropriate Minister

A further measure of the Forestry Act of 1947 provided for the dedication of private woodland to forestry purposes, and dealt with such matters as the enforcement of dedication covenants in England and Wales and of dedication agreements in Scotland This measure proved very contentious, and has been subject to considerable modifications

Lastly, a New Forest Act, 1949, was passed just after the period of this report. The Act amends the contribution of the verderers and gives them certain additional powers Provision was also made to enable the verderers to authorize the enclosure of additional land up to a maximum of five thousand acres, for the purpose of growing timber, and the enclosure of a maximum of three thousand acres for cultivation and improvement of grazing The long-standing problem of the ancient and ornamental woods was met by providing that the verderers may authorize the Commissioners, subject to certain conditions, to make enclosures, individually not exceeding twenty acres in area, for the rehabilitation of these woods

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* Forestry Commission Thirtieth Annual Report of the Forestry Commissioners for the Year ending September 30th, 1949 Pp 148+15 plates (London H M Stationery Office 1950) 4s net

RADIO-WAVE PROPAGATION AT VERY HIGH FREQUENCIES

THE radio communication engineer is continually seeking opportunities of using the shorter wave-length portions of the radio spectrum for services and applications of various types Reference was made recently in *Nature* (April 21, p 617) to the fact that the report of the Beveridge Committee on broadcasting in Great Britain directed attention to the need for actively developing the use of frequencies above 30 Mc /s. (wave-lengths shorter than 10 m) in order to relieve the congestion in Europe in the medium- and long-wave bands, and to provide a greater diversity in the broadcasting programmes available in Great Britain The present British television service is being developed in the frequency range 41–68 Mc /s , while a band of frequencies in the region of 90 Mc /s. is available for the development of sound broadcasting

It was thus very timely that, at a meeting of the Radio Section of the Institution of Electrical Engineers held on April 11, three papers were read describing the results of recent investigations on the propagation of waves at certain very high frequencies. The first of these, entitled "A V H F Field-Strength Survey on 90 Mc /s ", by H L Kirke, R A Rowden and G I Ross, describes measurements made by staff of the British Broadcasting Corporation on the radiation from an experimental transmitter at Wrotham in Kent. Automatic field-strength recording equipment was installed in a vehicle which cruised at a speed of about 1 m p h over a distance of from 50 to 500 yd in the neighbourhood of each point selected for observation In this manner measurements were made in various directions from the transmitter up to distances of some 60 miles, which includes the whole of the London area and a considerable portion of south-east England

It was found that, while the field-strength varied markedly with small changes in position in a built-up area or along a tree-lined road, useful and consistent results could be obtained from the averages of the recorded readings Thus, it was shown that buildings of normal height in London reduce the average received field by 10–12 db , but the average for one street may be taken as the average for the district to an accuracy of about ± 4 db The variation of field-strength along the street is less with horizontal than with vertical polarization In hilly country, the minimum field-strength occurred on the near-side slope of a valley and not at the lowest point On rising ground facing the transmitter, horizontally polarized waves gave stronger fields than vertical polarization, but, when once the peak of the hill has been passed, there is a range on the far-side slope in which vertically polarized radiation gives the stronger field, a fact which confirms the results of previous investigators. From all the results obtained in this work a predicted field-strength contour map has been prepared and is included in the paper This map refers to the power (25 kW) and aerial height (500 ft) of a B B C transmitting station now in experimental use at Wrotham This investigation has shown that when the Wrotham station is brought into full operation, it is likely to gave a satisfactory broadcasting service, defined by a field-strength of 2 mV /m or more, to Greater London and most of south-east England

The other two papers read at the meeting were under the common title of "The Propagation of Metre Radio Waves beyond the Normal Horizon" and describe some theoretical and experimental investigations carried out during the past few years by staff of the Radio Division of the National Physical Laboratory In Part 1, Dr J A Saxton considers the propagation of very-high-frequency waves over land, and discusses the relative importance of changes in atmospheric refraction near the surface of the earth and the reflexion of waves from high-level inversion layers. Using information on typical atmospheric conditions at various heights, obtained from the usual meteorological charts, the author presents some useful sets of graphs showing the field-strength to be expected at various distances up to 400 km (250 miles) from the transmitter The comparative influence on the received field of the three main factors—simple atmospheric refraction, guiding of the waves in a low-level duct, and reflexion from inversion layers—is well illustrated by these graphs Consideration is also given to the effects of scattering of radio energy by turbulent eddies in the atmosphere , but, except at distances exceeding about 250 km , it appears that such scattering is of less importance than the effect of the mechanisms of abnormal refraction, which may be deemed to include reflexion at elevated inversion layers

The third paper, forming Part 2 of the joint contribution, is entitled "Experimental Investigations at Frequencies of 90 and 45 Mc /s ", by Dr J A Saxton, G W Luscombe and G H Bazzard This describes the results of measurements of the field-strength on these frequencies over distances such that direct transmission from the sender to the receiver was impossible Two paths, of lengths 110 and 270 km., have been investigated on 90 Mc /s , and one of 160 km at 45 Mc /s The recorded field-strengths varied over a range of some 40 db , and there is some indication of a diurnal variation The statistical distribution of quasi-peak field-strengths as a function of time has been determined, and it is shown that values of field considerably in excess of those corresponding to standard atmospheric refraction often occur An attempt is made in the paper to interpret the observed field-strengths in terms of the meteorological data obtained from the routine radio sounding-balloon ascents made in Great Britain, and some degree of correlation has been obtained The results of such investigations are of considerable importance in planning radio communication services for operation over distances well in excess of the normal optical range, and also in enabling an assessment to be made of the extent of any mutual interference likely to be experienced between broadcasting and other services operating in the same frequency channel

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Optical Methods in Crystal-Structure Determination

DURING the war years, Sir Lawrence Bragg put forward several interesting suggestions for the application of the principles of physical optics to crystal-structure determination[1,2]. These methods seem to us to be of particular importance at the present time in order both to ease the burden of calculation which has enveloped the subject and also to introduce new *experimental* methods of tackling the initial stages of a structure investigation.

The methods suggested by Bragg were two-fold: first, the summation of Fourier series by optical interference[1], and, secondly, the use of optically derived Fourier transforms[2]. The first suggestion has been developed with some success by Buerger[3,4], and we are also hoping to make use of it on somewhat different lines; but the second method seems at present to be more fruitful, and the present communication is intended to give a brief account of the principle, with an illustration of its beauty and the rapidity with which it leads to results.

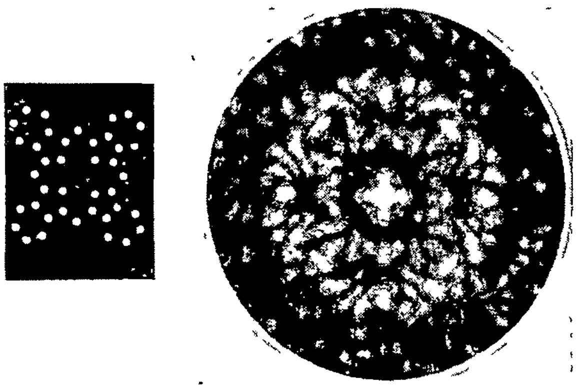
(*a*) (*b*)

Fig 1 (*a*) Mask representing molecule of phthalocyanine in plan (*b*) Optical diffraction pattern of this mask

The apparatus used is essentially similar to the X-ray microscope described by Bragg[1]; however, in view of the use of instruments which may now be described accurately as X-ray microscopes[5], we prefer to re-name our instrument the 'diffraction spectrometer', since this emphasizes its main purpose, namely, the observation of diffraction patterns of relatively large-scale objects. A description of the instrument is contained in a paper to be published in *Acta Crystallographica*[6].

Phthalocyanine[7] affords almost an ideal illustration of the method. A model of the molecule, which is known to be planar, is prepared as a mask of holes punched in black cardboard; the mask used is shown full size in Fig 1,*a*. Its diffraction pattern is shown with a magnification of about 20 in Fig 1,*b*. The variations in intensity of this optical diffraction pattern are equivalent to the variations in scattering of X-rays from a single molecule, and the pattern is, in fact, a representation of Knott's molecular scattering factor[8]. In crystals, we have to deal with a large number of molecules periodically repeated, and the effect of this repetition is to cause the scattered X-rays to be reinforced in specific directions only; in these directions the energy scattered is much greater than that scattered by a single molecule; but we have to pay a heavy price for this advantage, in that in other directions no appreciable amount of energy is scattered at all.

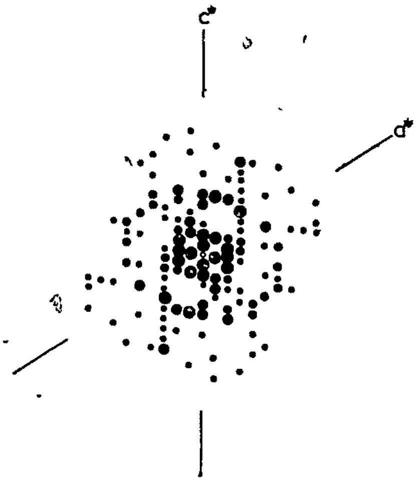

Fig 2 $h0l$ section of reciprocal lattice of phthalocyanine; the intensities correspond roughly to the areas of the spots

The directions in which X-rays are scattered by the crystal are represented by the reciprocal-lattice points, and if these points are weighted with quantities proportional to the intensities of the corresponding X-ray reflexions, we have a complete representation of the data from which the crystal structure has to be worked out. From the optical point of view, the derivation of a crystal structure is the process of fitting the weighted reciprocal lattice on the diffraction pattern of the single unit so that complete correspondence of weak and strong points in the two is obtained. In practice, of course, the operation can be carried out only in two dimensions, and consequently only one section of the reciprocal lattice can be considered at a time.

Another difficulty also exists: crystals do not contain only one molecule in each unit cell, and thus

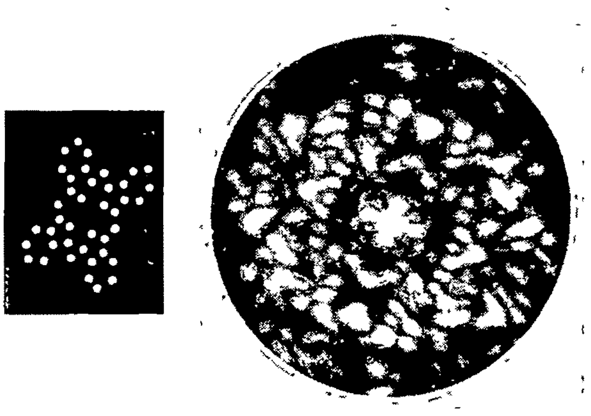
(*a*) (*b*)

Fig 3 (*a*) Mask representing projection of molecule in the orientation deduced (*b*) Optical diffraction pattern of this mask

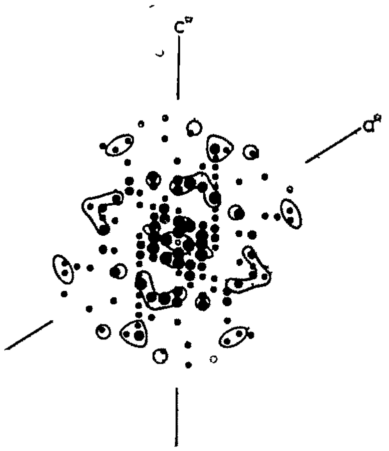

Fig. 4. As Fig. 2, with outline of prominent features of Fig. 3,*b* superimposed

we have normally to consider two or more symmetrically related molecules as a single diffracting unit. This difficulty, however, does not exist for the (010) projection of phthalocyanine, since the two molecules have similar projections separated by $a/2$, and thus the unit cell of the projection is effectively only half the size of the true unit cell.

Fig. 2 is a representation of the $h0l$ section of the reciprocal lattice, the observed intensities corresponding roughly to the areas of the spots; the origin is represented by an open circle. It is not difficult to see the general correspondence between Fig. 2 and Fig. 1,*b*; there is a grouping of strong intensities around the origin, then a gap containing only weak intensities, and then a ring of stronger intensities corresponding with the approximately square-shaped pattern in Fig. 1,*b*. The correspondence, however, is not perfect, because the molecule does not lie in the (010) plane; some rotation from this plane is required, and this will have the effect of elongating the diffraction pattern in a direction perpendicular to the line about which the molecule is rotated. The roughly symmetrical nature of Fig. 2 (which can be best seen by partly closing the eyes) suggests that the molecule is rotated about one of its axes of symmetry, and that this axis of rotation is approximately equidistant from a^* and c^*.

The required tilt can be roughly deduced from the elliptical ring of stronger spots in Fig. 2; and Fig. 3,*a* shows a new mask made to correspond to the tilted molecule. Fig. 3,*b* shows its diffraction pattern, and Fig. 4 shows some of the prominent features of this pattern superimposed upon the reciprocal-lattice section shown in Fig. 2.

It will be seen that the correspondence is quite close, and, in fact, the orientation of the molecule obtained in this way agrees to within a few degrees with that obtained by Robertson[7]. Perfect correspondence is not to be expected, because an ideal molecule has been assumed and there are also errors in the masks themselves. The method is only suggested for use in the initial stages of a structure determination, and, once a rough correspondence has been found, orthodox methods of refinement must then be brought into play.

Phthalocyanine provides a special case for application of the method, in that the unit cell of the projection contains only one molecule, and that the molecule is planar. Discussion of the further problems that arise when these conditions do not obtain will be published elsewhere.

We wish to express our thanks to the Department of Scientific and Industrial Research for a grant towards the building of the apparatus.

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Design of Multiple-Monochromators

CONVENTIONAL prism monochromators have two main limitations: a limited resolution due principally to the finite size of the prism; and impurity of spectrum owing to light scattered from various optical components, particularly the prism. A great improvement in these two respects can be obtained by a simple method which converts a single-monochromator into a double- or multiple-monochromator.

The principle of the method (for which a provisional patent specification has been lodged) can be illustrated by describing the conversion of a typical monochromator, shown in Fig. 1, to a double-monochromator. When used normally, radiation passes through the entrance slit S_1 and falls on the collimating mirror M_1, which sends a parallel beam to the prism P. The dispersed beam is reflected back on to M_1, which focuses radiation of a given wave-length on the exit slit S_2.

Suppose the mirror M_2 is set so that radiation of wave-length λ_1 falls on the exit slit S_2. Radiation of other wave-lengths will be in focus at other points on the focal curve OA of the mirror M_1. By placing two plane mirrors M_3, M_4 at right angles to each other and with their apex on OA, radiation of a given wave-length λ_2 will be reflected back to M_2, through the dispersing system and finally through the exit slit S_2.

Radiation which has passed only once through the optical system will be referred to as 'first-order' radiation, and radiation which, by means of mirrors M_3, M_4, has been twice through the optical system as 'second-order' radiation. It will be clear that, for a given setting of the mirror M_2, first-order radiation of wave-length λ_1 will pass through the exit slit at the same time as second-order radiation of a different wave-length λ_2. In order to isolate the two orders a

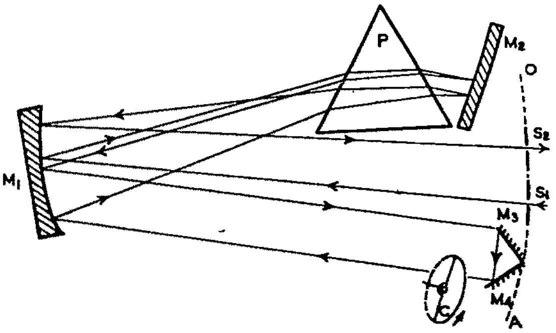

Fig. 1. Diagram illustrating method for converting a single- to a double-monochromator

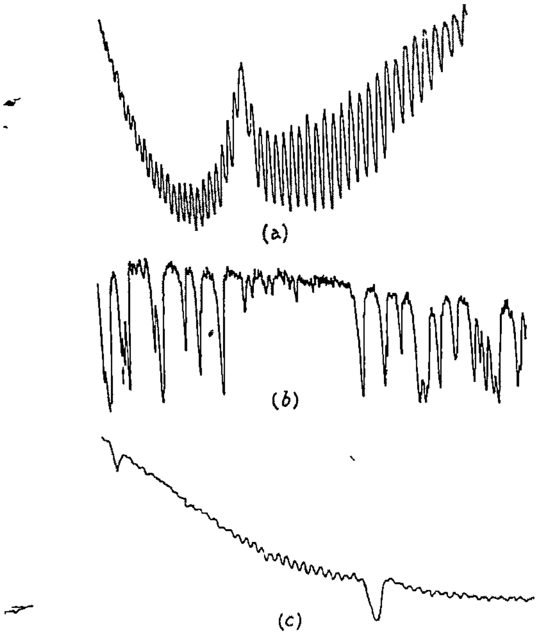

Fig 2 (*a*) 4 3-μ band of carbon dioxide, using a lithium fluoride prism The separation of the individual rotational lines is 1 5 cm^{-1} (*b*) Portion of 6-μ band of water vapour, using a calcium fluoride prism The lines indicated by the arrow (left) are separated by 0 5 cm^{-1} (*c*) 15-μ band of carbon dioxide, using a sodium chloride prism The separation of the individual rotation lines is 1 6 cm^{-1}

rotating chopper is arranged to interrupt the radiation reflected from M_4, and the signal from the detector is passed to an amplifier tuned to the same frequency as the chopper Thus, the first-order radiation, which is not chopped, gives no signal at the output of the amplifier, and only the second-order spectrum, which is chopped at the correct frequency, produces an output signal

A Perkin–Elmer infra-red spectrometer (Model 12*C*) has been converted into a double-monochromator by the method described above Typical spectra obtained are shown in Fig 2. The resolution obtained is about twice that obtainable with the original instrument, and the scattered radiation is too small to be detected, even at 15 μ where the scattered light often exceeds 10 per cent of the signal in the first order By using prisms of fused silica, lithium fluoride, calcium fluoride, sodium chloride and potassium bromide, it is believed that the instrument developed will yield a resolution of better than 1 5 cm^{-1} over most of the wave-length range 2–25 μ

The adaptation of the above principle to the construction of a multiple-monochromator will be obvious A full discussion of the design and performance of multiple-monochromators will be published shortly

My colleague, Mr J L Farrant, has pointed out that the single-prism type of double-monochromator described above could be readily adapted to Shurcliff's[1] modification of Golay's[2] multi-slit system, and will deal with this subject in a future publication

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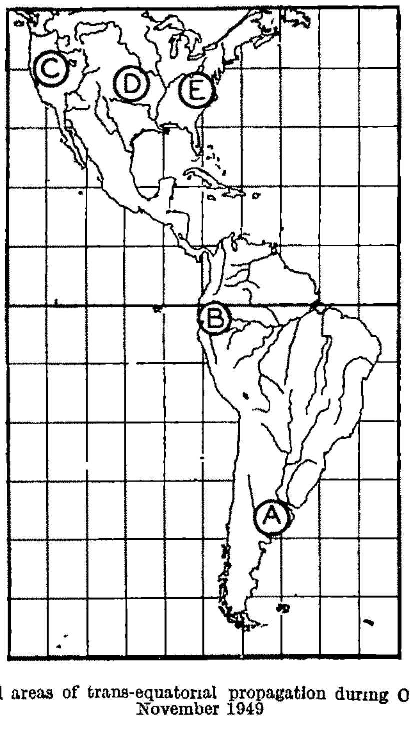
Enhanced Trans-Equatorial Propagation following Geomagnetic Storms

Experimental evidence has been obtained over a relatively large geographical area in the western hemisphere confirming the existence of abnormally high F_2-layer densities during, or shortly after, geomagnetic disturbances The observed effect of these high F_2-layer densities is to propagate radio frequencies at least 20 per cent above the median maximum usable frequency of the period in question

It has been found that moderate geomagnetic activity in the equatorial region does not appear to be accompanied by a depression in the penetration frequency of the F_2-layer Several workers[1] have also shown that the penetration frequency is often increased above the 'normal' for that period Appleton and Piggott[2] have recently reconciled the variations of geomagnetic ionospheric storm manifestations with latitude Their studies have shown that in the equatorial region a 'positive phase' or enhancement of the F_2-layer occurs simultaneously with the maximum depression of the F_2-layer densities in the temperate latitudes

Several hundred observations have recently been obtained by this organization from radio amateurs in North and South America These observations were taken during the latter part of 1949 in the 6-metre radio-amateur band on frequencies between 50 0 and 51 0 Mc /s [3]

It has been shown that the maximum usable radio frequencies during the sunspot peak of 1947–48 for transmission via the F_2-layer was of the order of 45 0 Mc /s in the 'W' zone[4] During an extremely small percentage of the total time throughout the sunspot peak, communication across the North Atlantic Ocean was possible using frequencies greater than 50 0 Mc /s [5] This occurred most frequently during the days of little geomagnetic activity Analysis of the reports just received showed that communication between North and South America was most fre-



Terminal areas of trans-equatorial propagation during October–November 1949

Date (1949)	Huancayo storms Start*	Cessation*	Activity†	50 0 Mc /s propagation Start	Cessation	Areas (see map)
Oct 13	2013		*s*	—	—	—
Oct 16		0800	*s*	1426	2005	*A* and *B* to *C*, *D* and *E*
Oct 27	0450		*m*	—	—	—
Oct 28		0600	*m*	1306	1745	*A* and *B* to *D* and *E*
Nov 1	0953		*ms*	—	—	—
Nov 2			*ms*	1740	1900	*A* to *C*
Nov 3		0500	*ms*	1747	1857	*A* to *C*
Nov 19	0604		*s*	—	—	—
Nov 20		0700	*s*	1353	1630	*B* to *C*, *D* and *E*

* ( ) represents continuing storm

†, storms are described by three degrees of activity *m* for moderate, *ms* for moderately severe, *s* for severe

quently affected during, or shortly after, moderately severe, or severe geomagnetic storms

The accompanying table shows the reported geomagnetic storms at Huancayo and the periods when 50 0-Mc /s communication was possible The periods of possible communication during the storm dates represent approximately 70 per cent of the total time when communication was possible between the areas indicated

It would appear, from these observations, that the enhancement of radio propagation conditions may possibly exist at all longitudes throughout the entire equatorial region

The 'opening' of frequencies in excess of 50 0 Mc /s for oblique incidence F_2-layer propagation strongly suggests that the 'positive phase' described by Appleton and Piggott may continue for 12–18 hr after cessation of the geomagnetic storm More evidence and further study on this effect are desirable

This study was made possible by the whole-hearted co-operation of a large number of radio amateurs scattered throughout twelve countries of the western hemisphere Their interest and assistance in providing the observational material are gratefully acknowledged The evaluation of the data was performed by the staff of this organization

The investigations resulting in this work have been sponsored in part by the Geophysical Research Directorate of the Air Force Cambridge Research Laboratories

OLIVER P FERRELL
Radio Amateur Scientific Observations,
121 S Broad Street,
Philadelphia, Pa Jan 11

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Absolute Measurement of Microwave Power in Terms of Mechanical Forces

A LOW-LOSS cavity having input and output wave guides, and containing a movable element, can, in principle, be used for measuring microwave power absolutely

It is necessary that in at least one position of the moving element the cavity acts as a reflexionless transition between input and output wave-guides The force acting on the element in this position is a measure of the power flow

Let the position of the movable element be specified by a co-ordinate x_2, and let the matching position of x_2 be x_{20}. The component of generalized force acting in the direction of increasing x_2 under these conditions we denote by F_2, defined so that $F_2 dx_2$ is an infinitesimal energy change

If the output wave-guide is matched, and the power flow is P, we have

$$F_2 = \frac{P}{2c} \quad \frac{\lambda}{\lambda_{g_3}} \left[- \frac{\partial x_3^{(1)}}{\partial x_2} - \frac{\partial x_3^{(2)}}{\partial x_2} \right].$$

In this expression, c is the velocity of light, λ is the transverse electromagnetic wave-length and λ_{g_3} is the wave-length in the output wave-guide

The bracketed factor is determined by two auxiliary experiments (distinguished by the superscripts) in which the matched load is replaced by a perfectly reflecting piston at x_3, and a standing-wave indicator is used to locate nodes in the input wave-guide In the first experiment $x_3^{(1)}$ is given any arbitrary value $x_{30}^{(1)}$, and, with x_2 equal to x_{20}, a node is located by the standing-wave indicator, say at $x_1^{(1)}$ Then x_2 and $x_3^{(1)}$ are adjusted in such a way that the node remains at $x_1^{(1)}$, and from the resulting set of values $\partial x_3^{(1)}/\partial x_2$ is determined at $x_2 = x_{20}$

The second experiment is similar to the first, except that we take $x_{30}^{(2)} = x_{30}^{(1)} + \lambda_{g_3}/4$

The general relationship between force and power quoted above can be deduced from the adiabatic invariance of action in a loss-free cavity[1]. It has given satisfactory agreement with other methods in calibrating the radiation-pressure power-measuring apparatus previously described[2]

An interesting special case is the rotary phase shifter described by Fox[3] If the central 'half-wave plate' section is allowed to rotate on its axis from a suitable suspension of known specific couple, the torque T exerted on it could be measured and would give the power flow according to the formula $P = \frac{1}{2}\omega T$, where P is the power flow and ω the angular frequency Moreover, there would be no reflexion of power for any deflexion of the movable part in principle, and angles of deflexion exceeding 2π are not excluded

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Dec 18

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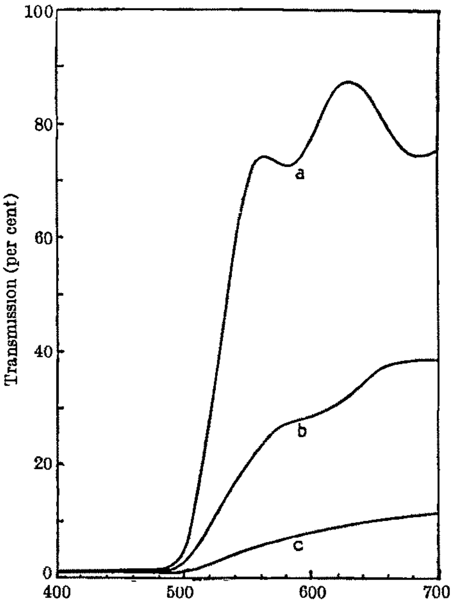
Preparation of Photoconducting Cadmium Sulphide

CADMIUM sulphide, when suitably prepared and in the form of relatively large crystals, is an interesting and important photoconducting material, with high sensitivity to many forms of radiation, including visible and ultra-violet light, X-rays, gamma- and beta-rays, etc.[1]

The usual method of preparation is by a vapour-phase reaction at a temperature of 1,000°–1,100° C, between hydrogen sulphide and cadmium in the presence of hydrogen[2] Yellow hexagonal crystals are obtained in the form of flat plates 0 1 mm thick and 1 cm long when the furnace used is 10 cm in diameter

A new method has been developed for the preparation of photoconducting cadmium sulphide surfaces, the process possessing considerable advantages over that outlined above Cadmium sulphide is precipitated from an aqueous solution of cadmium sulphate



Spectral transmission of evaporated cadmium sulphide layers on glass, the sulphide facing the light beam, evaporated at pressures (*a*) less than 10^{-6} mm., (*b*) 5×10^{-6} mm., (*c*) 5×10^{-5} mm. mercury respectively

by hydrogen sulphide gas, and the precipitate filtered off, washed and dried. The resulting yellow powder is then evaporated *in vacuo* from a molybdenum boat on to clean glass or rock-salt surfaces, the latter when it is desired to remove the substrate by solution in water. Surfaces of any desired area and of thicknesses up to 5×10^{-4} cm. have been prepared in this way.

The photoconducting properties are almost identical with those of crystals prepared by the high-temperature furnace method, providing certain conditions are observed during evaporation, namely, an adequately low pressure and a slow rate of evaporation.

The effect of gas pressure during evaporation is extremely critical, and is shown in the accompanying graph, where spectral transmission curves are given for three surfaces evaporated at pressures of (*a*) less than 10^{-6} mm., (*b*) 5×10^{-6} mm., (*c*) 5×10^{-5} mm. mercury respectively. The colour of the film changes from a pale yellow to black, with a corresponding increase in the specific resistance in the dark (from 10^{-8} ohm^{-1} cm.$^{-1}$ to 2×10^{-3} ohm^{-1} cm.$^{-1}$ respectively). Photoconducting properties are absent or small in samples (*b*) and (*c*). The changes are probably associated with a slight oxidation of the film, for both the colour and the photoconducting properties are completely restored by heating in dry hydrogen at 350° C.

The best sensitivity is obtained for layers evaporated slowly, typical values being 10 amp./watt for a tungsten filament source at 2,600° K., at a field-strength of 1 kV./cm. across a section of the layer 1 mm. wide and 1 cm. long, for a layer evaporated at the rate of 0.01 mgm. per sq. cm. per min.

The process is particularly suitable for the preparation of uniform surfaces of large area suitable for optical measurements for the determination of the type of activating centre, and for use in photoconducting camera tubes, or for the large-scale preparation of photoconducting elements. The process and photoconductivity measurements are being extended to evaporated layers of related selenides and tellurides.

Acknowledgments are made to the Commonwealth Scientific and Industrial Research Organization, Physics Division, for spectral transmission measurements, and the Radiophysics Division for the use of vacuum equipment.

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Silicone Oil Vapour and Secondary Electron Emission

THE current tendency to use oil instead of mercury vapour in diffusion pumps led us to carry out experiments of two kinds on secondary electron emission using silicone oil (*DC* 703). From our findings, we consider that its vapour will produce obnoxious results on any surface when bombarded by electrons.

In one series of experiments the 'sticking' potential of a fluorescent powder was determined. This potential is, in our case, defined as the higher of the two potentials at which the secondary emission coefficient δ is unity. The pressure was measured by an ionization gauge, which was calibrated in a mercury system, and it gave a reading of 5×10^{-6} mm. mercury in the system used for the experiments.

It was found initially that the values of 'sticking potential' were in quite good agreement with many of the published figures[1]. However, under electron bombardment the secondary emission falls within thirty minutes, and the 'sticking potential' drops from some 8–12 kV. to 2.5 kV. The rate of fall is dependent on the bombarding current density which, in these experiments, ranged from 0.8 μamp./cm.^{2} up to 16 μamp./cm.^{2}. Specimens bombarded at the higher currents showed slight brown staining; but at lower values of current no discoloration was visible. A similar fall was observed on 'Hysil' glass, although in this case the drop was very small, the 'potential' falling from 2.4 kV. to 1.8 kV. A nickel cap which was bombarded in the vacuum showed interference colours on its surface, in patterns corresponding to the bombarded areas. All these measurements were reproducible.

In the other series of experiments, the secondary emission coefficient was measured for various surfaces in an 'orbital beam' electrode system[2]. The electrodes and system were much more highly degassed than was possible in the first series of experiments. A tungsten filament was used as a source of primaries, and the vacuum produced during these experiments gave readings corresponding to a pressure of 2–3 $\times 10^{-6}$ mm. mercury. One of the secondary emissive substances investigated was a mixture of magnesium and barium oxides[2]. On heating the secondary cathode to 1,000° C., and allowing it to cool, the value of δ was found to be about 5, but it could not be measured accurately on account of the rapidity of fall under electron bombardment. In a matter of seconds, δ decayed to approximately 1.5. The process of decay and recovery by heating could be repeated several times until eventually, after one or two hours bombardment, the secondary cathode became coated with a dark deposit. This deposit was most intense on the more heavily bombarded areas. The value of δ was then permanently lowered, even after very strong heating. Dark marks were also seen on the uncoated metal of the secondary cathode where electron bombardment had occurred The nature of this black deposit was not determined, but it might be noted that the same deposit was also found on the anode and glass bulb of the ionization gauge Furthermore, the use of a water-cooled baffle in this system produced no change in the phenomena

Thermionic emitters such as tungsten and alkaline earths are not seriously affected by the silicone, the emission being as good as in an ordinary demountable system For example, over long periods, the tungsten filament of the ionization gauge could be operated as a thoriated emitter

It is supposed that a silicone film on the bombarded electrode is decomposed, whereas a thermionic cathode remains hot enough to prevent much silicone remaining on it It would seem, therefore, that great care should be exercised in interpreting the results of experiments which are made in vacua containing silicone vapour

We wish to acknowledge the continued interest and help of Drs H Moss and C S Bull in the above work. and to thank Electronic Tubes, Ltd, for permission to publish these results.

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A B McFarlane

Electronic Tubes, Ltd,
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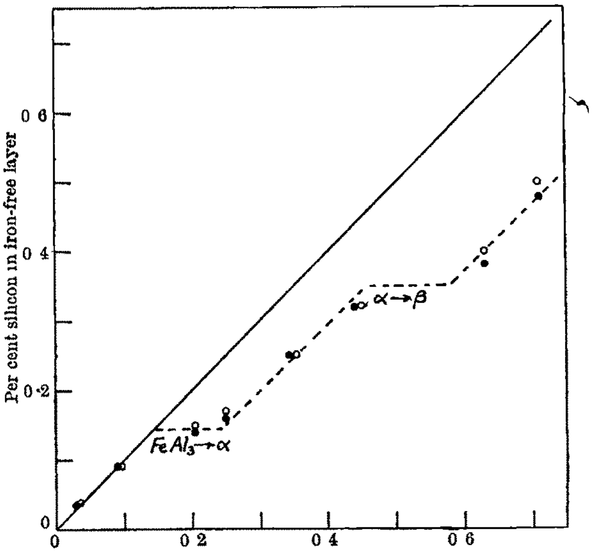
Determination of Phase Boundaries in Solid Alloy Systems by a Diffusion Technique

The accurate determination of equilibrium conditions in solid alloys containing three or more elements sometimes presents considerable difficulty when the alloying metals are present in only small proportions Direct X-ray examination is not always feasible, and indirect methods, such as the measurement of electrical conductivity, may fail because the changes in properties are often comparatively slight

We have recently been investigating the equilibrium constitution of aluminium–silicon–iron alloys containing 0 5 per cent iron and 0–0 75 per cent silicon, that is, within the range of commercial-purity aluminium, at temperatures from 450° to 600° C The technique used is both direct and simple, and since, so far as we can ascertain, it has not previously been applied in this way, a brief description may be of interest

The principle of the method is to segregate the co-operating phases of an alloy on a scale which although it allows equilibrium to be attained by a diffusion anneal, is yet sufficiently coarse to allow differential chemical analysis to be carried out without difficulty This can be done very simply by hot-rolling together, and so welding, fairly thick plates of different alloys to form a 'sandwich', the alloys being chosen so that certain phases will appear only in one layer of the composite sheet The total analysis of the sandwich corresponds, of course, to the composition of alloy it is desired to investigate The composite sheet is rolled down to an appropriate thickness, annealed until diffusion is complete, and the separate layers then analysed to determine the final distribution of the mobile element or elements



Results on alloys containing 0 5 per cent of iron heat-treated at 475° C ●—●—, for 320 hr, ○—○—, for 500 hr

In the aluminium–silicon–iron system, the solubility of iron is very small, and $FeAl_3$ appears at quite low concentrations All that is needed in this case is to determine the distribution of silicon between the aluminium solid solution and the $FeAl_3$ phase, with which it is known to form, under appropriate conditions, two ternary compounds α(Fe–Si) and β(Fe–Si)[1], and may also show solid solution effects The sandwiches prepared, therefore, consisted of only two layers, of equal thickness, one containing 1 0 per cent iron and the other twice the concentration of silicon required in the final alloy

At 550° and 600° C, material 1 0 mm thick was used Samples for chemical analysis could then be taken from both sides of the heat-treated sheet by skimming in a lathe At lower temperatures, the thickness was reduced to 0 25 mm to allow equilibrium to be attained in a reasonable time, and the procedure then adopted was to fix the sheet to a metal block with adhesive, with the iron-rich side uppermost, and to grind it down to a thickness of about 0 1 mm A determination of silicon on the $FeAl_3$-free side remaining and on the full thickness of the sandwich gave all the required information

The accompanying graph shows the results obtained in some tests at 475° C In this we have plotted the percentage of silicon found in the $FeAl_3$-free side against the total silicon determined on the full thickness of the sheet The silicon combined with the $FeAl_3$ is then given by the horizontal displacement of the experimental points from the line which has been drawn in at 45° It will be seen that the approximate range of silicon contents over which α(Fe–Si) and β(Fe–Si) are stable at this temperature can be determined without difficulty from the data

It is hoped that it will be possible to publish elsewhere a detailed account of the results obtained by the application of this technique

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[1] Phillips, H W L, and Varley, P. C, *J Inst Metals*, **69**, 317 (1943)

Molecular Orientation and Light Absorption

RECENT discussions by several authors[1-5] have stressed the importance of considering the orientation of molecules in the measurement of light absorption in cytological material

In a system of molecules having parallel orientation (anisotropic system), the incident vibration is decomposed into two perpendicular components These components are differently absorbed (dichroism) In many cases, however, the light absorption of such systems is measured with unpolarized light. If the transmission (I/I_0) of one component is a and the other b, the total transmission for unpolarized light can be shown to be $(a + b)/2$ If the same molecules are randomly orientated in the same space, the transmission will be $\sqrt{ab}$ Thus, by measuring the light absorption of an anisotropic system using unpolarized light, a systematic error will be introduced, depending on the ratio of a to b The magnitude of this error must be investigated experimentally for each special case

The following summarizes some results for nucleic acids The preparation used was deoxyribose nucleic acid made according to Hammarsten Two types of experiments were carried out

In the first, nucleic acid molecules in solution were orientated by streaming in the apparatus designed by Signer[7] (1,100 r p m , radius of rotating cylinder, 24 75 mm , distance between rotating and fixed cylinder, 0 5 mm , light-absorbing layer, 50 mm) As a light-source for 260 mμ a Beckman spectrophotometer (band-width 1 mμ) was used The intensities were measured by a 1P28 photomultiplier The amplified photocurrent was recorded by an Esterline Angus meter (0–5 m amp) An interchangeable Glan prism was inserted between the streaming apparatus and the photomultiplier tube The dichroism and the absorption of unpolarized light of orientated and unorientated molecules in the same solution were measured The results of a typical experiment are presented in the accompanying table

The second type of experiment was made with an apparatus especially devised for microscopic specimens The constructional details of this apparatus will be published elsewhere[6] The molecular orientation was brought about by stretching a nucleic acid gel into microscopic fibres or strips Some results of measurements similar to the above are summarized in the table

It is evident from the first type of experiment that, with moderate degrees of orientation, giving a dichroism (E_a/E_b) of 1 3, the error lies within 2 per cent at a transmission of 50 per cent at 260 mμ (in the direction of higher transmission values)

In the second type of experiment it is interesting to note the high values of dichroism in freshly made fibres The deviation or error calculated from these values will be 6 per cent at 50 per cent transmission At lower transmission values, however, the deviation will be considerable

In cytological material (with few exceptions, for example, sperm heads), the dichroism of nucleic acid generally is very low[1], detectable only with specially designed instruments[6] Thus, it seems clear that the effect of molecular orientation on the cellular nucleic acid absorption of unpolarized light does not introduce any serious error, such as has been assumed[2,3]

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Experiment	Orientated molecules					Unorientated molecules Transmission (v) of unpolarized light (260 mμ)		Per cent deviation $\left(\frac{v-u}{v}\ \ 100\right)$
	Dichroism Transmission (260 mμ)		Extinction quotient	Transmission (u) of unpolarized light (260 mμ)				
	$a = \frac{I_a}{I_0}$	$b = \frac{I_b}{I_0}$	$\frac{-\log a}{-\log b}$	measured	calc	measured	calc	
I (streaming)	0 11	0 06	1 3	0 09	0 082*	0 09	0 078*	5
II (fibres)	0 72	0 36	3 2	0 53	0 54	—	0 51	6
,,	0 34	0 03	3 2*	—	0 18	—	0 11	64

* Calculations give approximate values, as the molecules are not completely orientated by this method

Applications of Multiple-Beam Interferometry

Two recent communications on applications of multiple-beam interferometry, one by Bruce[1], the other by Bruce, Macinante and Kelly[2], call for critical comment

Bruce has described two applications of transmission-like multiple-beam interference fringes in reflexion These are applied to (*a*) the method I have already described[3] for measuring the thickness of thin films, and (*b*) the interferometric method for measuring oscillations described by Tolansky and Bardsley in 1948 [4a]

Doubtless this modification has some advantages in very limited cases, but it will be of interest to find whether the method used (which, incidentally, is not fully described) can really be extensively employed in the examination of the complex topographies now so frequently under examination with multiple-beam interferometry Although the application is of interest, the principle of the method of converting reflexion into transmission-like fringes by cutting out beams is not at all new It was, of course, first discussed in detail by Otto Lummer fifty years ago[5] I have long been familiar with this, having taught it to a succession of students for more than fifteen years, and having used it in interferometrical studies occasionally, though not to very much advantage In simple low-magnification cases it is not difficult to cut out individual beams , but with the higher-power microscopic observations now often used the matter may not be so simple and may well lead to diffraction anomalies in the image

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Bruce is too severe in his criticism of reflexion fringes I have shown in connexion with reflexion Fabry–Perot fringes[6,7] that the critical factor affecting visibility is not the reflectivity but the absorption of the front film Although the quality of reproduction in the note by Bruce makes it difficult to form a reliable judgment, it appears to me that his silver films have too big an absorption With correct attention to this detail, it is possible to secure very sharp reflexion fringes of high contrast (see illustration of page 149 of ref 3), and they can be, and have been, used quite well for oscillation experiments (see ref 4)

The second communication[2], by Bruce, Macinante and Kelly, describes the use of a stroboscopic method with multiple-beam interference fringes for studying oscillations The authors are obviously not aware of the fact that in April 1949 I gave an account[8,9] of the way Mr Bardsley and I have for some time been successfully using stroboscope methods in combination with interferometric studies on oscillating crystals As I have already pointed out, the stroboscopic method we use not only permits larger amplitude measurements to be made, but also, and much more important, reveals relative phases[4b].

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Decomposition of Radioactive Octamethylpyrophosphoramide in Living Plants

Gardiner and Kilby have described[1,2] the synthesis of the systemic insecticide *bis*(*bis*-dimethylaminophosphonous) anhydride (octamethylpyrophosphoramide) in radioactive form (with phosphorus-32) and its application to the study of its uptake by living plants[2] We also have experimented along these lines, but have extended our investigations to the study of the chemical fate of the substance, using for this purpose activities of about 400 μC /gm to obtain the necessary sensitivity in analysis Preparative details will be published elsewhere

In vitro, acid hydrolysis of the phosphoramide occurs at a rate determined by $k = 3\ 6 \times 10^{-3}$ [H^{+}] min^{-1} at 25° C , and alkaline hydrolysis by $k = 4\ 7 \times 10^{-3}$ [OH^{-}] min^{-1} at 100° C Only powerful oxidizing agents and halogens react more rapidly Water itself does not react at a measurable rate Thus in the *p*H range of plant tissues, 4 5–7 0, the half-life *in vitro* would be more than eight years

We find, however, that only about 10 per cent of the toxic compound originally absorbed by plants in vigorous growth is present unchanged four weeks after spraying Up to a further 50 per cent is present as decomposition products The rate of decomposition is considerably dependent on state of growth and is particularly slow in winter-dormant plants, facts which are consistent with the decline in insecticidal activity already established[3] The contrast with the stability in non-living solutions indicates that some enzymic process is responsible for the decomposition in plants

The water-miscible amide in dilute solution at 25° C partitions 7 1 in favour of chloroform from water and 23 1 from *N* aqueous sodium hydroxide All products of inanimate hydrolysis carry a hydroxyl group on the phosphorus atom and are therefore retained by aqueous alkali, and we have found no evidence of any metabolite soluble in chloroform but having a different partition ratio with water To estimate the toxic material, therefore, plant samples are macerated with water, filtered and the aqueous extract, containing most of the activity, made alkaline and extracted with chloroform The radioactivity of aqueous and chloroform layers is measured in an annulus-type Geiger–Muller tube With a small correction for incomplete extraction, the chloroform count gives the amount of unchanged compound Further partition experiments show no evidence of any other chloroform-soluble compound

The decomposition products are mostly precipitated by calcium salts in alkaline solution Some light is thrown on the mechanism of decomposition in the plant by following the fate of hexamethylorthophosphoramide This has similar physical properties to the pyro-compound, but is not hydrolysed by alkalis, as this is a property of the P—O—P bonding We find that the living plant decomposes the ortho-amide as rapidly as the pyro- When an aqueous extract normal in sodium hydroxide is partitioned exhaustively with chloroform, little of the decomposition products are in this case not extractable, most appearing as a compound with partition coefficient (chloroform/*N* aqueous sodium hydroxide) of 1 2 as against 17 0 for the ortho-amide Hydrolysis of the P—N links must give POH groups, products containing which on partition go solely into *N* sodium hydroxide The initial site of attack by the enzymes is therefore not the P—N link but either the N—C or C—H links Substitution of carbon by hydrogen or hydrogen by hydroxyl decreases the partition in favour of chloroform The absence from the pyro-amide products of any substance extractable by chloroform from alkali may result from instability of the P—O—P links during the action on the N—C—H system

It is therefore probable that the mechanism of decomposition is wholly different from that of inanimate hydrolysis Attack on the N—C—H system is not surprising in view of the known abundance of methylamines in plants, whereas the unusual N—P link is much less likely to find an enzyme designed to attack it

Our thanks are due to Mr D Lane and Mrs M V Llewellyn for assistance in the preparative and analytical work , also to the directors of Pest Control, Ltd , for permission to publish this note

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Spontaneous Gelation of Alkaline Casein Dispersions

In a communication in *Nature* of February 10, Plomley, Higgins and Hayes describe the dependence of viscosity and rate of gelation on *p*H Their results are in general agreement with those obtained in this laboratory for lactic casein and denatured peanut protein spinning dopes, dopes to be spun into fibres must obviously have considerable stability to allow time for filtration and de-aeration

The authors mention that search for the specific groups concerned in the gelation process is proceeding. There are a number of indications that the specific group concerned in gelation is the sulphydryl group[1]. Oxidation catalysed by oxidative enzymes increases the tendency to gel

$$R - SH + O + HS - R^1 = R - S - S - R^1 + H_2O$$

Milk casein and peanut protein dopes containing sodium sulphide are much more stable than dopes of similar alkalinity not containing sodium sulphide, the latter agent would inhibit the formation of disulphide bonds

There is a *p*H (*c* 12 5) giving maximum stability for both milk casein and peanut protein dopes, if milk casein dope containing *c* 20 per cent lactic casein and 0 50 per cent free caustic soda is made more alkaline by the addition of 50 per cent more caustic soda, the dope becomes a gel after two days at 25° C, but if the additional alkali is in the form of sodium sulphide, the change in viscosity is quite small. At very high alkalinity, the ultimate decline in viscosity is likely to be due to hydrolysis

Thomson and Traill[2] have explained the peculiar behaviour of peanut and other seed protein dopes in terms of denaturation and chain rupture Both these factors are important, but the irreversible nature of the gel suggests cross-linkage formation, and the most likely link appears to be the well-known disulphide bond In comparing denatured peanut protein dopes with milk casein dopes, both types of dispersions show similar sequences of viscosity changes, but the peanut dispersions are more sensitive to change, and this would be in accordance with their higher cystine content

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Electrolytic Oxidation and Reduction of some Pyridine Compounds

As part of an investigation for developing satisfactory procedures of preparing 2-, 3- and 4-pyridine-aldehydes, attention was turned to the electrolytic oxidation and reduction of pyridine compounds After consideration of commercially available pyridine derivatives, studies were made of the electro-oxidation of 2-, 3- and 4-picoline and of 2-vinyl-pyridine and the electro-reduction of picolinic, nicotinic and *iso*nicotinic acids Inasmuch as the results do not show promise of being successful with respect to the primary object, the work has been abandoned Nevertheless, some of the observations are interesting, although several points need further inquiry

Other than minor modifications for electrolyses carried out at elevated temperatures, the basic arrangement consisted of a clay porous cup, for one cell compartment, sitting or suspended in a beaker, which served as the other cell compartment A mechanical stirrer was used for agitation More than a hundred electrolyses were conducted to observe the effect upon the yield of aldehyde when varying separately the type of electrodes, amperage, current-density, applied E M F, temperature, concentration of pyridine derivative, time of electrolysis, type of electrolyte at anode or cathode, or addition of an agent to precipitate the aldehyde as it is produced.

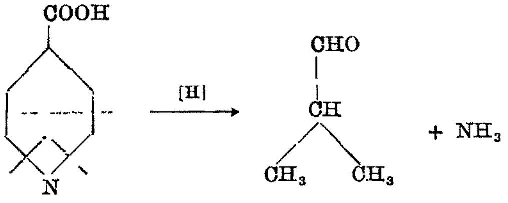
Aliquots from the solutions in the cathode compartment in reductions and from the anode compartment in oxidations were analysed for carbonyl and nitrogenous products A quantitative determination of the former was made by producing and weighing the precipitated 2,4-dinitrophenylhydrazone, and its qualitative identification was made through mixed melting points with authentic samples Ammonia was detected through its picrate by mixed melting points with known samples of ammonium picrate

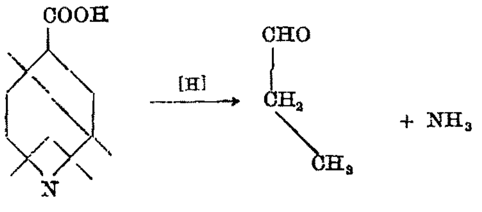
Products Obtained in the Electro-reduction of *iso*Nicotinic Acid

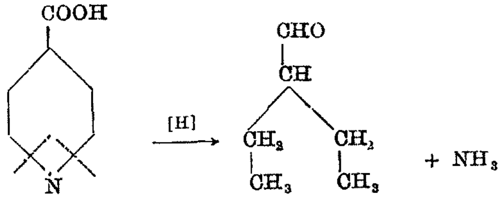
Type of cathode	Applied E M F (volts)	Product
Tin foil	6	23 4% CH_3CH_2CHO
Lead plate	6	Identity unknown*
Platinum black	6	10 7% $(CH_3)_2CHCHO$
Mercury-pool	5	28 7% ,,
,,	4	21 4% ,,
,,	3	$(CH_3CH_2)_2CHCHO$†

* Known not to be any of the other aldehydes in this table
† Identity not conclusive

In the reductions, the surprising observation was the profound effect that the type of cathode and applied E M F has upon the mode of cleavage of the nucleus of *iso*nicotinic acid In the accompanying table are listed the aldehydes isolated as their 2,4-dinitrophenylhydrazones in the reduction of *iso*nicotinic acid It is noteworthy that the pyridine nucleus is cleaved in various ways, depending upon the conditions In each case ammonia was also produced Wibaut and Boer[1] and F Sorm[2] have







also studied the electrolytic reduction of *iso*nicotinic acid, and although the conditions in the three independent investigations do not differ greatly, the results from the three studies are different. To determine at what minimum potential production of aldehyde takes place and therefore, perhaps, avoid reduction of the ring, electrolyses were performed with a mercury-pool cathode at 2 volts Ammonia was easily detected, but the test for aldehyde was negligible at E M F 's below 2 4 volts, and the aldehyde was still aliphatic

In the oxidations of the picolines, the gamma isomer gave the best results; but the highest yield of 4-picolinealdehyde was only 16 8 per cent By making analyses at half-hour intervals during the electrolyses, it was found that the concentration of aldehyde reaches a maximum after about two hours and then decreases rapidly to a low level

In the oxidations of 2-vinylpyridine, analyses were also made for a glycol with periodic acid and silver nitrate Assuming the glycol to be 2-pyridyl-ethylene glycol, the highest yields of glycol and 2-pyridinealdehyde obtained were 6 and 3 per cent, respectively Relatively high potentials were required for the oxidations of 2-vinylpyridine, and this resistance towards oxidation of the side-chain is also observed in its resistance to chemical oxidation For example, 2-vinylpyridine and 4-stilbazole were found to be inert towards hydrogen peroxide in the presence of osmium tetroxide

This work was supported by a contract from the Office of Naval Research, U S Navy Department It is described in a thesis (A J L) presented in partial fulfilment of the requirements for the degree of master of science to Howard University in 1949, and was presented before the Division of Organic Chemistry of the Washington Chemical Society, November 1949

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Enzymatic Formation of Glutamohydroxamic Acid from Glutamine in Mammalian Tissue

THE presence of enzymes which catalyse the exchange of the amide group of glutamine and asparagine with amines[1-3] has been shown in cell-free extracts of micro-organisms The enzymatically catalysed exchange can be easily detected and assayed with hydroxylamine as the acceptor amine, since the γ-glutamo and β-asparto hydroxamic acids produced give the colour reaction with ferric chloride characteristic for hydroxamic acids The terms 'glutamo-' and 'asparto-transferase' activities were proposed for these enzymatic potencies since the mechanism of the exchange can be visualized as a transfer of the amino-acid radical from one amine to another

The rate of enzymatic exchange (cell-free extracts of *Proteus vulgaris*) is not influenced by the addition of phosphate or manganous or magnesium ions

We now wish to report on the presence (and some of the properties) of the enzyme system showing glutamotransferase activity in mammalian tissue Whereas homogenates of mammalian tissues with isotopic ammonia and normal glutamine as substrates promoted exchange of the amide group with ammonia (isotopic), the enzymatic formation of hydroxamic acids with hydroxylamine could not be unequivocally demonstrated in such tissue preparations Aqueous extracts of acetone dried powder of sheep's brain, liver and kidney showed no activity whatsoever However, the addition of manganous salts (but not of barium, calcium, magnesium, zinc, copper or cobalt) activated the transferase activity, which was enhanced considerably by the addition of phosphate Phosphate alone, without manganese, did not activate the enzyme A potent enzyme extract may be obtained by the extraction of acetone-dried tissue with water followed by precipitation at *p*H 4 2 (acetate), solution of the precipitate in water, and dialysis of the solution against water By this procedure, enzyme extracts potent after activation with manganous salts and phosphate have been obtained from sheep's brain cortex, sheep's liver and kidney cortex, mouse's liver and transplanted mouse sarcoma ♯ 180, kindly provided by Dr A Gellhorn (see table) It is noteworthy that these enzyme preparations (brain cortex) did not show any glutaminase activity when tested under optimal conditions (*p*H 8, phosphate concentrations 0 1 molar)

GLUTAMOHYDROXAMIC ACID FORMED (MICROMOLES) FROM GLUTAMINE IN CELL-FREE EXTRACTS OF MAMMALIAN TISSUES

	Sheep's brain cortex	Sheep's liver	Sheep's kidney cortex	Mouse's liver	Mouse sarcoma
Complete system	14 1	3 8	1 7	9 0	2 2
Without phosphate	1 3	0 6	0 1	4 3	0 6
Without manganous ions	0	0	0	0	0
Without phosphate and manganous ions	0	0	0	0	0
Glutamic acid instead of glutamine	0	0	0	0	0

The complete system contains, per 2 ml glutamine, 40 micromoles, hydroxylamine, 20 micromoles, phosphate and manganous chloride, 10 micromoles, 0 05 molar acetate, *p*H 5 5, 0 3 ml of tissue extract corresponding to 0 1 gm acetone-dried tissue powder Incubation, 2 hr at 35°

Though it was not possible to decide on the basis of the available evidence whether glutamotransferase activity in cell-free extracts of bacterial origin is associated with glutaminase activity, the two activities can be easily separated in mammalian tissues The enzyme extract did not catalyse the transfer of the glutamyl radical from glutathione to hydroxylamine, a finding of interest in view of the transfer of the glutamyl radical of glutathione to other amino-acids by enzymes present in sheep's kidney extracts[4] The optimum *p*H for glutamotransferase activity is about 5 5 (optimum *p*H for bacterial glutamotransferase is about 8)

Stumpf[5] has recently described an enzyme from sugar pumpkin seedlings which transfers the glutamyl radical from glutamine to hydroxylamine and also exchanges the amide-group with isotopic ammonia This enzyme is active only in the presence of phosphate (or arsenate) and manganese Whether the activation of the enzyme from mammalian tissues by manganese alone and the enhancement of this activation by phosphate point to an essential difference between the enzyme systems from mammalian and plant tissues cannot be decided at present Purification and characterization of the protein fraction of mammalian tissues endowed with glutamotransferase activity will also show whether these enzyme potencies belong to the group of enzymes responsible for the transfer of the glutamyl radical of glutathione to other amino-acids[4] and for the hydrolytic splitting of the tripeptide[6]

We are indebted to the Rockefeller Foundation and the National Vitamin Foundation for the support of this work

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Mechanism of Hydrolysis of Benzoyl Chloride

THE following general conclusions emerge from the extensive work on the alcoholysis of substituted benzoyl chlorides[1] (*a*) the changes in velocity constant with substituents are similar in all the various solvents used, (*b*) these changes fully support the contention that the reaction is a bimolecular S_N2 process

A similar order in velocity constants is not observed in the hydrolyses in 50 per cent acetone[2] and, moreover, the order is difficult to interpret in terms of any one mechanism[3] It has been suggested[3,4] that this is due to a change to a unimolecular S_N1 process, particularly when the chloride is substituted by methyl or methoxy groups If this is true, this tendency should be largely repressed on changing to a solvent of low dielectric constant, and if the reaction then proceeds mainly by the S_N2 process, the rate-order should be the same as for the alcoholysis

Substituent *p*-position	95 per cent aqueous acetone $(10^5 k_{25})$	40 per cent alcohol 60 per cent ether[5] $(10^5 k_{25})$	50 per cent aqueous acetone[2] $(10^4 k_0)$
CH_3O	2 92 *(2 64)	5 3	—
CH_3	2 69 *(3 46)	6 43	12 5
H	5 10	10 8	4 33
Br	15 5	22 3	4 0
NO_2	169 0	203 7	50 0

* 95 per cent dioxan solution (refers to 5 ml H_2O made up to 100 ml) Velocity constants k at 0° and 25° expressed in sec^{-1} units

The results in 95 per cent acetone show that, with the exception of anisoyl chloride, the predicted order is obtained On replacing the acetone by dioxan, thus giving a solution with a much smaller dielectric constant, anisoyl chloride hydrolyses more slowly than toluoyl chloride, showing that a complete reversal in velocity order may be achieved. It is of interest to note that the bimolecular reaction with *p*-toluoyl chloride proceeds somewhat faster in the dioxan solution ($D \sim 6$ 5) than in the acetone solution ($D \sim 24$ 5), which would be difficult to explain in the case of a unimolecular ionization reaction

On increasing the water content of the medium, the S_N1 mechanism readily preponderates in the most favourable cases, so that in 50 per cent aqueous acetone only the *p*-nitro compound is reacting entirely by the S_N2 mechanism On this basis, the methyl-, methoxy- and bromo-compounds and the unsubstituted chloride react almost entirely by the unimolecular process

We wish to acknowledge the financial help received from the Central Research Fund, and hope to report this work in detail elsewhere

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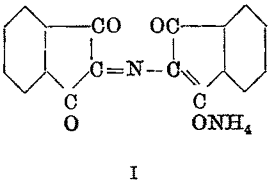
Possible Artefacts introduced by the Ninhydrin and Alloxan Reactions in Histochemical Applications

SINCE the work of Berg[1], the ninhydrin reaction has been commonly used as a histochemical test for the α-amino-acid groupings of proteins The reaction of proteins with alloxan, giving rise to murexide, has already been criticized by Romieu[2] for lack of specificity and by Giroud[3] for the diffusion of the colour

Our own experience shows that for two reasons caution is necessary when interpreting the results. The first is that the reaction products both of ninhydrin and alloxan with the α-amino-acid groups of proteins are to some extent soluble in water and thus may be adsorbed on cellular structures which are not the site of the reaction The second is that other cellular structures, containing proteins but lacking affinity for the coloured reaction products, will fail to stain In both cases the microscopical picture is misleading This can be clearly demonstrated on granules of the blood eosinophiles of the horse and the frog These structures give a very strong ninhydrin and a weaker alloxan test[4]

The chemical constitution of the reaction product of ninhydrin with amino-acids has been identified as the ammonium salt of 2-(1 3 diketoindanylideneamino)-indandione[5] (I)

The reactions between proteins and alloxan give rise to the formation of murexide, the ammonium salt of purpuric acid, which has a very similar structure (II)



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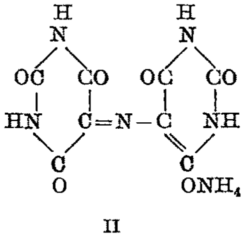

II

The reaction mechanism has been elucidated by Hurtley and Wotton[6] By means of these compounds in pure solutions, we obtained the same picture as when applying the histochemical test with ninhydrin and alloxan In these experiments the staining of the eosinophilic granules is not due to any chemical reaction of the amino-acid groups but to an adsorption process It is thought that the binding of the anionic dye, eosin, is due to electro-adsorption of this substance on positively charged cellular structures[4], in the same way that basic dyes are fixed on negatively charged substances[7] It is therefore not surprising that other anionic dyes, such as the ammonium salt of 2-(1 3 diketoindanylideneamino)-indandione and the ammonium salt of purpuric acid, are also fixed by eosinophilic structures

The ammonium salt of 2-(1 3 diketoindanylideneamino)-indandione was prepared by the slightly modified method of Ruhemann[5] Murexide was prepared according to Wohler and Liebig[8] (modified)

Smears of horse leucocytes fixed in methanol, were stained for 10 min with $7 \times 10^{-4} M$ of the ninhydrin derivative The eosinophilic granules were very strongly coloured Erythrocytes, occasionally present, stain faintly (as in the histochemical ninhydrin test) As can be predicted from the staining mechanism, the blue dye is completely displaced by strong concentrations of eosin ($1 54 \times 10^{-2} M$) Moreover, it can be washed out with ethanol When eosin is applied first, and the blue dye afterwards, there is a partial displacement of eosin, and the resulting colour of the eosinophilic structures is a uniform purple Remarkable staining effects could be obtained with less concentrated eosin solution (10 mgm /25 ml)

An application of eosin on smears, previously stained with the blue compound, completely displaces the dye in the erythrocytes but only partially in the eosinophilic granules Their inner part remains blue, while their outer layer is pure red This points to the heterogeneity of the granules already demonstrated by other means[4]. Further evidence for this fact is furnished by extraction with an ethanol–ether mixture, which strongly reduces the affinity for eosin but not for the blue dye

The curious staining effect may be explained by a stronger affinity of the inner parts of the granules for the ninhydrin derivative The same effect is obtained by staining the granules with eosin after staining them by the usual histochemical ninhydrin reaction

Similar results were obtained with murexide solutions, especially with frog leucocytes

In our opinion, the interpretation of histochemical protein localization obtained by the ninhydrin and alloxan test is very difficult, and our own results on the cytochemistry of blood eosinophiles[4] require re-examination

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A New Anti-Proteolytic Factor in Soya Beans

Aqueous extracts of raw soya beans have been shown to be capable of inhibiting proteolysis of casein by pancreatin[1] and trypsin[2] According to Read and Haas[3], they possess inhibiting action on trypsin and the proteinase of taka-diastase, but not on papain or bromelin

With a gelatin substrate, I found in 1947 a marked inhibiting power in aqueous soybean extracts not only on trypsin but also on papain Subsequent work has confirmed this finding, in contradiction of the results of Read and Haas, and has extended it to the proteolytic enzymes of malt flour More recently, a certain amount of evidence has been obtained that the inhibiting factor is effective on papain and the proteolytic enzymes of wheat flour, acting on a gluten substrate

The anti-papain factor is heat labile, and apparently more so than the anti-tryptic factor which has been examined in detail by Ham[2], Kunitz[4], Bowman[5] and others The existence of an anti-papain factor in raw soya beans appears not to have been noticed before

It is hoped to publish full details of this work elsewhere

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Fate of Radioactive Protein in the Animal Body

Protein tagged with radioactive iodine (iodine-131) is proving useful in immunological research because of its ready detectability[1] Also the firm substitution of the iodine in the tyrosine molecule renders conclusions based on the occurrence of radioactivity in the tissues more acceptable as evidence of the presence of the antigen or its partial breakdown products than has been the case with arsenic and dye tracers[2] The application of various methods including paper chromatography to the study of the fate of iodinated antigens has produced results which appear of general interest

In the present investigation, the fate of tagged antigenic protein has so far been followed in normal rabbits The proteins used have been purified bovine albumin, human γ-globulin and homologous whole serum In agreement with recent American work[3], it has been found that after intravenous injection much of the protein is removed from the blood-stream within forty-eight hours, and that there is a concomitant rise in the radioiodine content of the thyroid gland and the urine The iodine-131 appeared in the urine of all the animals studied within thirty minutes of the injection The excretion of iodine was greater when a foreign protein was used The excreted products were freely dialysable through 'Cellophane' and were not precipitated by protein precipitants, a feature noted also by Crampton and Haurowitz[4]

For further study of the substances excreted, paper chromatograms of the urine were set up on Whatman 3 *MM* paper and run overnight in phenol saturated with water On development with ninhydrin and heat, certain traces of purple indicated amino-compounds, but the most conspicuous feature was always the presence of bright yellow spots or streaks which differed in size and position with the protein injected In normal uninjected animals, the most conspicuous of these was the lower (R_F 0 40–0 48), but a fainter one was also present (R_F 0 73–0 78) After injection of albumin containing iodine-131, the lower spot was the more conspicuous, and after globulin containing iodine-131 the upper was usually so With homologous serum containing iodine-131, the spots differed little from those in normal urine Chromatograms were scanned with a β-particle counting Geiger–Muller tube placed directly on the paper Counts were made at closely placed sites along the trace With the foreign proteins it was found that approximately 50 per cent of the activity was in a spot (R_F 0 05–0 10) shown by a comparative tracer to represent inorganic iodine With albumin injections a second peak of activity was found in relation to the lower yellow spot, with globulin it was in the upper yellow spot With the homologous serum, inorganic iodide was proportionately greater, but some activity coincided with the lower yellow spot also In one animal, activity was associated with a conspicuous purple spot (R_F 0 85), which was probably diiodotyrosine, in the remainder this compound appeared to be absent This latter finding concurs with that of Leblond and Sue[5], though it is at variance with that of Foster and Gutman, all of whom worked with free diiodotyrosine It also differs from the findings of Knox and Endicott (see ref 1, addendum to paper), who studied the fate of foreign labelled-proteins in rabbits They reported that diiodotyrosine and iodide formed the chief excretion products

It was thought that the compounds responsible for the yellow spots were polypeptides, and confirmation was obtained by hydrolysis Both the whole urine and also the eluate from the 'yellow spot' area of undeveloped chromatograms were hydrolysed in $6N$ hydrochloric acid In each case the hydrolysate was resubmitted to chromatography in phenol and developed with ninhydrin Six separated purple spots representing amino-acids were found, and some of the radioactivity was now associated with diiodotyrosine Some, however, was still found in a mixed yellow–purple spot (R_F 0 45–0 50), which area was accordingly eluted from an undeveloped chromatogram When run in an *n* butanol – acetic mixture, this was resolved into a further five non-radioactive purple spots (R_F ranging from 0 2 to 0 45) and an active yellow one above this Further elution and hydrolysis followed by chromatography in phenol revealed more amino-acid spots, which again included radioactive diiodotyrosine

It would appear, therefore, that in the animal the injected proteins are subjected to hydrolysis, which results in the breakdown of part of the molecule and release of inorganic iodide, but also in the release of some stable peptides that still contain iodine in organic combination The peptide and such of the iodide as is not stored in the thyroid are then excreted in the urine It also appears that the excreted peptide may differ according to the protein used, although further investigation with other proteins is required to test this point Examination of the excretion products of labelled proteins appears to offer possibilities to workers in a wider field than that of immunology

I would like to express thanks to Mr R W R Baker for valuable assistance in preparing and interpreting the chromatograms

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Histochemical Observations on Genital Cancer

The histochemical test of McManus[1] and Hotchkiss[2] demonstrating the presence of mucopolysaccharides, mucoproteins and glycoproteins was carried out on cancerous tissue of the vagina, portio and corpus uteri, the Fallopian tube and the ovary The polygonal stratum of the normal epithelium of the portio gives an intense positive test, while the normal stratum basale remains uncoloured Cancerous tissue fails to give a positive test even in the pre-invasive intra-epithelial stage The same result was obtained in cancers originating from other parts of the genital tract Thus our observations indicate that the McManus–Hotchkiss test is a valuable tool in the early diagnosis of cancers in the pre-invasive stage

In view of the report of Shetlar *et al* [3,4] that in cases of malignant tumours the protein-bound polysaccharide content of serum albumin is increased, it is of interest that compounds of this nature seem to be absent in the cancer cells This may indicate that protein-bound carbohydrates may be concerned in some way with malignancy

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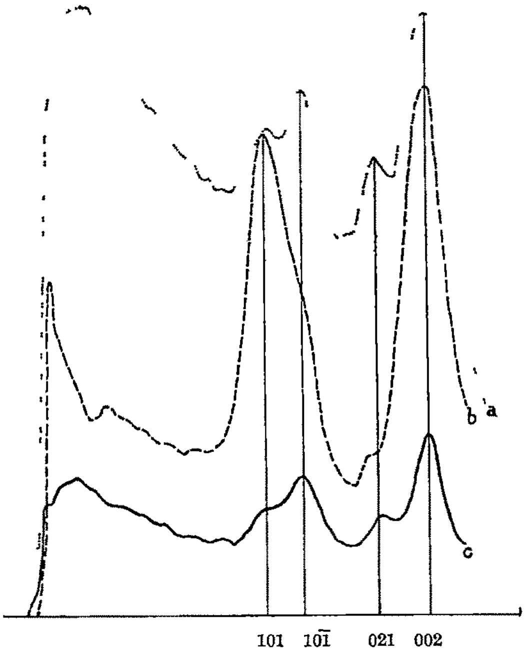
Micellar Structure of Native Cellulose

Ranby and Ribi[1] have recently described how native cellulose particles of micellar dimensions can be produced by boiling cotton fibres in dilute sulphuric acid and then washing to a *p*H of approximately 4 We have examined the effect on cotton and ramie of more concentrated acid at lower temperatures (for example, 975 gm /l and 20° C) and have obtained somewhat similar results We find that with increasing severity of our treatment the ultimate product of the dissolution appears to consist of particles between 500 and 2500 A in length with a roughly constant cross-section (50 A thick and 150–200 A wide) In the earlier stages of disintegration larger flat aggregates are obtained, and we have been able to prepare brittle transparent films from the colloidal solution of these X-ray examination of such films shows that, when the X-ray beam is perpendicular to the film, the 101 and $10\bar{1}$ reflexions of cellulose I appear as rings, as they



Photometer records of X-ray photographs of films of cellulose particles (*a*) X-ray beam perpendicular, (*b*) beam parallel, equator, (*c*) beam parallel, meridian The intensity scale for (*a*) is different from that for (*b*) and (*c*)

should, but the former is abnormally weak in intensity When the beam is parallel to the film, a strong 101 reflexion appears on the equator, and $10\bar{1}$, partly oriented on the equator and partly on the meridian, is weak in comparison Photometer records showing these results are given in the accompanying diagram The 101 planes are thus preferentially oriented parallel to the plane of the film Since the aggregated particles are themselves flat and must thus tend to lie down parallel to the same plane, we deduce that the crystal axial orientation tends to persist throughout the aggregates

We have not yet been successful in preparing a specimen in which only the ultimate particles appear, but we have observed similar orientation effects in films made from solutions in which the majority of the particles exist as units or very small aggregates This suggests that the ultimate particles are themselves thinnest in the direction normal to the 101 crystallographic planes, a suggestion which is supported by a careful examination of electron micrographs of disintegrating aggregates, in which the width of the ultimates appears to lie in the plane of the flat sheets Whether the occurrence of crystallographic orientation in the aggregates is a consequence of the shape of the ultimates, or is rather due to the different activities of the 101 and $10\bar{1}$ surfaces, cannot as yet be decided, but a more detailed study of some slight differences between the orientation effects in cotton and ramie may throw some light on this question

It is also noteworthy that, in our X-ray photographs of the less drastically treated material, there appears a strong equatorial small-angle scattering and an equatorial streak (cf. diagram, *b* and *c*) The former in particular is considerably weaker in the corresponding photographs of more completely disintegrated material, and may thus be associated with the details of the building up of the aggregates from the ultimate particles Both it and the streak are clearly due to some effect in the direction of the normals to the 101 planes

It is also interesting to note that our attempts to obtain the native cellulose particles from raw jute have been unsuccessful, since the cellulose passes over into the cellulose II modification before the fibres disintegrate* This suggests that in jute some of the lignin may be present as an intermicellar cement, as we have reason to infer from evidence obtained in other investigations on this fibre[2,3]

* *Note added in proof* In more recent experiments we have been able to obtain a very small quantity of native cellulose particles from jute when the conditions of treatment were very carefully controlled Even in the most favourable circumstances, the yield of particles from jute is very much less than from ramie or cotton

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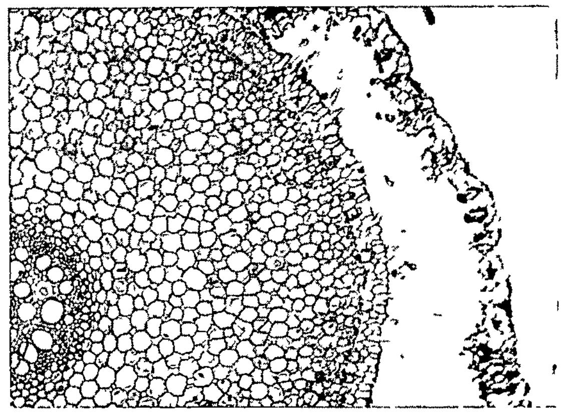
A Secondary Piliferous Layer on the Roots of *Hippeastrum*

DURING the examination of a *Hippeastrum* plant the roots of which were badly attacked by a new species of the nematode genus, *Rotylenchus*, to be described elsewhere, it was noticed that some of the undamaged parts of the roots were covered with root hairs right up to the base of the bulb Closer examination showed that the root hairs were of secondary origin, for in some cases the root was still surrounded by the original hypodermis, which was partially sloughed, and the new root hairs were growing beneath it

Secondary root hairs have been described by Pinkerton[1] in certain members of the Commelinaceæ but in the cases she investigated the secondary root hairs arose from trichoblastic cells occurring between the already existent primary root hairs In the case here reported it appears that the secondary root hairs have arisen from cortical cells below those constituting the hypodermis, and have formed a new piliferous layer So far as I am aware, the phenomenon of the production of a secondary piliferous layer has not



been reported before , certainly Cormack[2] makes no mention of it Outside the new piliferous layer, the hypodermis, of which the old piliferous layer appears to have died, has been sloughed This hypodermis is usually two cells in depth but in some places is as much as five cells deep The cells and root hairs of the secondary piliferous layer appear to be no different from those of the primary layer

The cells of the root cortex seem to be able to become meristematic with ease, and the new piliferous layer is formed from a meristem of this origin Another manifestation of the same meristematic activity is seen when the root is damaged by eelworm attack The lesion formed tends to be isolated by a series of cells which have divided tangentially on the inner side of the lesion A similar phenomenon was described by Quanjer[3] from potato tubers attacked by the eelworm *Ditylenchus dipsaci*, where a cork cambium was produced, isolating the lesion

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Anatomical Factors of Body-Heat Regulation

As has already been shown, the body-weight/body-surface ratio decreases more or less regularly from north to south, and the lowest averages are found in hot climates[1,2] Manifestly the decrease of the weight/surface ratio in human beings is an anthropological—and strictly biometrical—equivalent of the two well-known zoological 'laws' Bergmann's rule (body-size of related homeotherms decreases in the warmer parts of their geographical range), and Allen's rule (relative increase of protruding organs in warmer districts) I think that a biometrically correct rule may be generalized in the following way in closely related homeotherms, the body-mass/body-surface ratio tends to decrease in climates which, at least during a part of the year, put a stress on heat-eliminating mechanisms

Now, the weight/surface ratio is correlated with many anthropometrical indices, suggesting that there are anatomical factors of heat regulation The following experimental results show that thermal behaviour varies according to body-build, a correlative of weight/surface ratio

In the first experiment, mature adult men were exposed for about one hour to a dry-bulb temperature of approximately 36° C Thereafter they were divided into two groups (1) subjects reacting by strong perspiration (sweat dripping down profusely at least on a part of the body forehead, chest or axillæ) , (2) subjects reacting by a moderate perspiration (shiny skin, but not perceptible drops) I did not take into account subjects difficult to put in one of these well-defined groups As neglected subjects represent probably the 'average' cases, perspiration appears in these results as a dichotomized variate, excluding the hypothesis of a normal distribution Therefore, in order to calculate correlations, the point-biserial *r* formula was employed The coefficients of correlation between the intensity of perspiration and some anatomical indices are given in Table 1 (number of subjects 43)

Table 1

Trunk volume/total limb length (Viola)	0 461
Lower limb/trunk height	0 443
Weight/height (Quetelet)	0 342
Upper limb/lower limb	0 252
Abdominal volume/thoracic volume (Viola)	0 224
Thoracic depth/length of sternum	0 202
Body-weight/body-surface ratio	0 336

These figures show that profuse perspiration tends to be associated with the eurysomatic morphological trend relative preponderance of trunk volume over limb length, of trunk height over lower limb, of upper limb over lower, of abdomen volume over chest volume, of chest depth over sternal length, of body mass over body surface Of course, moderate perspiration tends to combine with the opposite leptosomatic trend

These results may seem a little paradoxical It is stated in text-books that perspiration is the chief method of heat elimination But perspiration increases with weight/surface ratio and the latter decreases as we go south Nevertheless the paradox disappears if we remember that the "chief method of heat elimination" is the least economical and the most disturbing On the average, brachymorphic individuals perspire too quickly and too profusely sweat is largely lost without being evaporated It is a kind of physiological 'hypertely', which can be compared with the mammoth's tusks usually quoted

The second experiment threw some light on this aspect of the problem A group of young adult men was submitted for half an hour to a dry-bulb temperature of 36° C Their mouth temperatures were carefully taken before entering the hot room, then again at regular intervals Leaving aside the intermediate cases, we can distinguish two groups (1) ten subjects whose temperature rose to a maximum at the tenth minute , (2) eleven subjects whose temperature rose to a maximum at the thirtieth minute The characteristics of both groups are given in Table 2

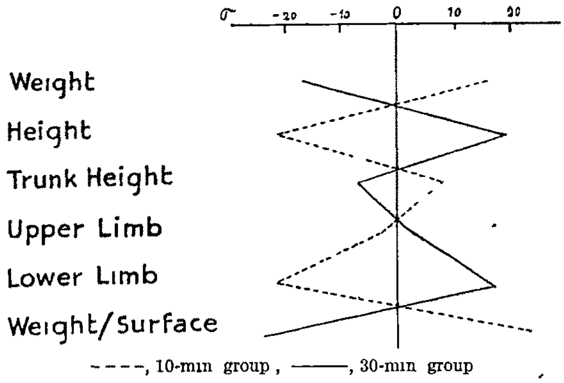
Table 2

	10-min group	30-min group
Maximum temperature (° C)	36 9	36 8
Heat gained in order to reach max temperature (Cal)		
per minute	1 7	0 7
per minute and kgm of body-weight	0 025	0 011
Weight/surface ratio (kgm /m ^{2})	37 7	36 7

The maximum temperature reached by the 30-min group was still lower than the maximum attained by the 10-min group The latter accumulated more heat (the heat gain was calculated by taking 0 83 as average thermal capacity of living tissues)

Six subjects of the 30-min group were observed for 40 min In one case the temperature rose a little during the additional 10-min period , in a second case it remained at the 30-min level , in four cases there was a temperature fall obviously related with intensified perspiration Therefore, the 30-min group, with a lower weight/surface ratio, gains heat at a slower rate and its 'last resource' sweat reaction is delayed and relatively weak On the whole, thermal reactions of the 30-min group are more economical and more efficient

Now the anthropometrical profiles of the two groups show perfect anatomical antagonism In the accompanying graph, averages of each group are compared with averages of the whole sample and



their deviations from the latter are expressed in standard deviations. Thus, all characters are comparable and we can determine relative anatomical preponderances. For the 10-min group we find a relative preponderance of weight over height, of trunk height over pelvic limb length, of upper limb over lower limb; the 30-min group shows the opposite relative preponderances. On the average, the first group is manifestly eurysomatic, the second is leptosomatic. This 'bipolar deformation' coincides with other anatomical gradients revealed by the study of anthropometrical changes as functions of blood pressure and muscular strength, the latter being taken as independent variables[3].

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Poria monticola Murr. on Chir (*Pinus longifolia* Roxb.) in India

Poria monticola Murr. (= *Poria microspora* Overh.) has so far been known to occur naturally in North America (Canada and United States), where the fungus commonly causes heart rot of living trees (sitka spruce and Douglas fir) as well as decay of coniferous wood in service. The fungus is not known to occur naturally in Great Britain, and is only present in timber imported into the country from North America. During the Second World War, Messrs. Tata Aircraft, Ltd., Bombay, obtained from Canada a supply of 36,000 cu. ft. of sitka spruce for manufacturing aeroplane parts in India. A large number of the planks showed an infection in the form of brown streaks of rot running along the length of the grain. Isolations from the diseased wood yielded a fungus which resembled *Poria monticola* described in culture by Nobles[1] and others. The pockets were superficial and therefore the rot was removed by planing off the surface, and any incipient decay that might have gone inside the wood was arrested by kiln seasoning. The growth of the fungus is also known to be checked if the moisture content of the wood remains less than 20 per cent, based on the oven-dry weight of the wood.

Chir (*Pinus longifolia*) is an important timber species in the central and west Himalayas. The logs are converted in the felling coupes and are floated, along with other timber species, down the rivers into the plains. All these are collected at Dakpathar, Dehra Dun, which is situated at the foot-hills of the Himalayas on the banks of the River Jumna, which comes into the plains at this region. One of us (K. B.), during numerous inspections of timber at Dakpathar, collected chir sleepers, which were frequently affected by a brown rot. Isolations from the rotted wood yielded *P. monticola* in culture. It therefore appears that the fungus is present in a natural condition in India, and that it can be traced into the felling coupes of chir plantations in the Himalayas. Recently, a large consignment of chir sleepers was obtained by the Public Works Department, Government of India. The sleepers were stored in a godown adjacent to the Forest Research Institute, Dehra Dun. The conditions of storage were very unsatisfactory, with poor ventilation. The humidity of the air at Dehra Dun is high during July to September, when there is an average rainfall of 80 in. and the average temperature of the place in summer months is about 95° F. As a consequence, a dry-rot fungus affected and spread rapidly into all the sleepers by the end of September 1949. Thick hyphal mats developed on the surface (Fig. 1), and occasionally fruit bodies were formed (Fig. 2) which corresponded with *P. monticola* described by Murrill[2]. The rot was of the brown carbonizing type. Isolations from the rot yielded *P. monticola* in culture. Advice was given to reject the sleepers where the rot penetrated into the core, while those with superficial rot and incipient stages of decay were given a sterilizing treatment in steam under pressure and restacked in the open under cover to allow free circulation of air around them. All such sleepers have been found to be healthy up to this date. The fungus caused a severe brown rot on chir sapwood blocks in culture flasks, and the average loss in weight of the blocks was found to be 63 per cent in four months.

(1) Hyphal mats (left) of *Poria monticola* on the surface and (right) shrinkage cracks and initial stages of rot on a chir sleeper. × 1/10
(2) Fruit bodies of *Poria monticola* on a chir sleeper. × 2/5

Dr. W. P. K. Findlay, to whom the isolate from chir was sent, stated that the fungus is probably *Poria monticola*, to which view we agree from a study of its cultural characters. A detailed account of the fungus will appear elsewhere in a study by us of the fungus diseases and decays of conifers in India.

K. BAGCHEE
B. K. BAKSHI

Mycology Branch,
Forest Research Institute and Colleges,
Dehra Dun, India. Dec. 20.

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[1] Nobles, M. K., *Canad. J. Res.*, **C26**, 389 (1948).
[2] Murrill, W. A., *Mycologia*, **12**, 90 (1920).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, May 21

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Prof K R Popper "A Critical Discussion of Operationalism and related Views"

Tuesday, May 22

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1 p m —Mr Denis McMahon "Practical Training for Psychology Students—the Work of a University Psychology Unit"

Society of Public Analysts and Other Analytical Chemists, Physical Methods Group (at the Institute of Physics, 47 Belgrave Square, London, S W 1), at 4 p m —Radiochemistry Meeting

Royal Anthropological Institute (at 21 Bedford Square, London, W C 1), at 5 30 p m —Mr Paul Bohannan "Divination among the Tiv of Central Nigeria"

Royal Society (at the Institute of Marine Engineers, 85 Minories, London, E C 3), at 5 30 p m —Prof L C Burrill "Sir Charles Parsons and Cavitation" (Parsons Memorial Lecture)

British Ornithologists' Union (joint meeting with the Systematics Association, at the Zoological Society of London, Regent's Park, London, N W 8), at 6 p m —Dr Ernst Mayr "Birds and the Origin of Species"

Society for Visiting Scientists (at 5 Old Burlington Street, London, W 1), at 7 30 p m —Discussion on "The Biological and Chemical Control of Insect Pests" (Speakers Dr V B Wigglesworth, F R S, Dr R A E Galley, Mr G V B Herford and Dr G S Hartley)

Wednesday, May 23

Royal Society of Medicine, Endocrinology Section (joint meeting with the Society for Endocrinology, at 1 Wimpole Street, London, W 1), at 2 p m —Symposium on "A C T H"

Chemical Council (at the Royal Institution, Albemarle Street, London, W 1), at 3 p m —Sir Jack Drummond, F R S "Chemistry and the Food We Eat" (Chemistry in the Service of Man, 2)

Institution of Electrical Engineers, Supply Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Sir Edward MacColl "Hydro-Electric Power Development in Scotland"

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W C 1), at 5 30 p m —Mr M S C Birbeck "Histological Techniques for the Electron Microscope"

United Nations Fellowship (in the Ceylon Room, Royal Empire Society, Northumberland Avenue, London, W C 2), at 8 p m —Discussion on "Bi-National Cultural Activities" *

British Psychological Society, Medical Section (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W 1), at 8 30 p m —Dr W S Inman "The Moon, the Seasons and Man"

Institute of Metals (at 4 Grosvenor Gardens, London, S W 1)—Sir John Anderson, F R S Annual May Lecture

Thursday, May 24

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 4 45 p m —Dr D J Bell "Biological Syntheses concerning Carbohydrate Radicals" * (Further Lectures on May 31, June 7 and 14)

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m —Mr J L Thompson "The Resistance Wire Strain Gauge in the Measurement of Physical Quantities"

Friday, May 25

Physical Society (in the Lecture Theatre Science Museum, Exhibition Road, London, S W 7), at 5 p m —Sir George Simpson, F R S "Fifty Years' Work in Geomagnetism and Geophysics—Some Reminiscences" (6th Charles Chree Address)

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p m —Mr L Atkinson "High Voltage Oscillograph for Photography of Transients"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Lecturer in the Department of Engineering, Wednesbury County Technical College—The Director of Education, Department F E, County Education Offices, Stafford (May 26)

Mechanical Engineer in the Heavy Research Plant Section of the Chief M and E Engineer's Division, Ministry of Works—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 259/51A (May 26)

Scientific Officers (2) (with at least second-class honours degree with mathematics or physics as main subject, or an engineering degree with a very strong mathematical background) to deal with mathematical problems arising from research into civil defence fundamentals—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 148/51A (May 26)

Principal Medical Officer (Research) at a Ministry of Supply establishment in south-west England, to organize and superintend investigations into the physiological, pathological, pharmacological and biochemical effects of toxic materials—The Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W C 1, quoting J O 35 (May 28)

Agricultural Economist and Assistant Agricultural Economists, grade (*a*) or (*b*), in the Department of Agricultural Economics—The Registrars, The University, Manchester 13 (May 31)

Assistant Lecturer in Mathematics—The Clerk, Birkbeck College, Breams Buildings London, E C 4 (May 31)

Coats Fellowship in Chemistry or Physics (excluding nuclear physics)—The Clerk of Senate, The University, Glasgow, W 2 (May 31)

Engineer I at a Ministry of Supply establishment in south-east England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 205/51A (May 31)

Engineer I in the Ministry of Supply Directorate of Ordnance Factories/Engineering, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 204/51A (May 31)

Principal Lecturer or Senior Lecturer in Heat Engines, a Senior Lecturer in Machines, Lecturers (2) in Machines, a Senior Lecturer in Physics, a Senior Lecturer in Electrical Engineering, a Lecturer in Electrical Engineering, a Senior Lecturer in Structural Design, and Demonstrators (13) in Mathematics, Physics, Chemistry and Engineering, at the Military College of Science, Shrivenham, Swindon—The Civil Service Commission, Trinidad House, Old Burlington Street, London, W 1, quoting No S 4026/51 (May 31)

Senior Bacteriologist and/or Microbiologist, to engage in fundamental research in brewing microbiology and allied fields—The Director, Brewing Industry Research Foundation, Nutfield, Surrey (May 31)

Senior Lecturers and Lecturers in Science and Engineering, a Senior Lecturer in Mathematics, and a Lecturer in Modern Subjects, at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W 1, quoting No 4027/51 (May 31)

Junior Fellowship in Applied Mathematics—The Registrar, The University, Bristol (June 1)

Physical Chemist (with a good degree with a strong bias towards physical chemistry) to act as team leader and to take charge of the laboratory under general direction from the B E A headquarters' organization, a Physical Chemist (with a good honours degree or expecting to obtain one shortly, thoroughly interested in the theory and the experimental techniques that are associated with corrosion research, and a capable experimenter), and an Experimental Officer to help with the experimental work (should have a good knowledge of chemistry and, preferably, have had experience of boiler operation or of the preparation and photomicrography of metallurgical specimens), in the Research Branch of the Chief Engineer's Department in London—The Secretary's Office (Establishments), Applications Section, British Electricity House, Great Portland Street, London, W 1, quoting Ref AE/150 (June 1)

Demonstrator (with a good honours degree in physiology, biochemistry or chemistry with subsidiary physiology) in Chemical Pathology—The Registrars, The University, Manchester 13 (June 9)

Research Officers (4) in the Section of Chemical Engineering, Division of Industrial Chemistry, Fishermen's Bend, Melbourne, for work associated with the Division's recently established fuels utilization research programme—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting No 3387 (June 9)

Lecturer in Astronomy—The Secretary, The University, Aberdeen (June 15)

Lecturer (with a Special Degree in botany or its equivalent) in the Department of Botany—The Secretary, Bedford College for Women, Regent's Park, London, N W 1 (June 15)

Physical Chemist (Scientist, Grade I) to take charge of investigations related to the improvement and discovery of processes for resolving complex mixtures of solids into their components (Ref TT/327), a Coal Preparation or Minerals Engineer (Scientist, Grade I) to take charge of laboratory, pilot plant and field investigations for the development of wet processes for cleaning coal (Ref TT/328), a Physical Chemist (Scientist, Grade II) for laboratory investigations of the underlying principles and mechanism of coal cleaning processes (Ref TT/329), a Coal Preparation or Minerals Engineer (Scientist, Grade II) for pilot plant investigations into coal cleaning by wet processes (Ref TT/330), a Physical Chemist (Scientist, Grade III) with not less than 2 years postgraduate experience in industry, preferably in the quantitative aspects of distillation and catalytic work on either laboratory or pilot plant scale (Ref TT/331), a Physical Chemist (Scientist Grade III) with experience in X-ray analysis (Ref TT/332), a Chemist or Chemical Engineer (Scientist, Grade III) for laboratory research on coal breaking, grinding and briquetting (Ref TT/333), and Chemical Engineers (Scientist, Grade III) to design and operate laboratory and pilot plant equipment with particular reference to distillation and catalytic processes (Ref TT/334)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting the appropriate Ref No (June 29 except Ref TT/328, August 31)

Aeronautical and Mechanical Engineers (Experimental Officer grade) at Ministry of Supply research and development establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 679/50A

Assistant Biochemist—The Secretary, Royal Infirmary, Bolton

Assistant Experimental Officers (2) for recording, plotting and analysis of locust movements and preparation of maps—The Director, Anti-Locust Research Centre, British Museum (Natural History), South Kensington, London, S W 7

Dairy and Poultry Officer in the Veterinary Department Northern Rhodesia—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27066/47

ELECTRICAL ENGINEER (Meters and Protection) by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M 25727 B

ENGINEER-GEOLOGISTS in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27079/18/51 .

FORECASTER by the Falkland Islands Dependencies Survey, for service in South Georgia and Port Stanley—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M 27292 E

HEAD OF THE COLLEGE—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N 7

LECTURER IN PHYSICAL CHEMISTRY—The Registrar, College of Technology, Union Street, Bristol 1

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Hungary Builds a New Education By Max Morris (Hungary Today Series, 4) Pp 16+16 plates (London Hungarian News and Information Service, 1950) *6d* [132

Forty-third Annual Report of the Governing Body of the Imperial College of Science and Technology Pp 51 (London Imperial College of Science and Technology, 1951) [132

Anti-Locust Bulletin 6 Reproduction in the African Migratory Locust (*Locusta migratoria migratorioides* R and F) in relation to Density and Phase By Dr Maud J Norris (Mrs O W Richards) Pp ii+50 (London Anti-Locust Research Centre, c/o British Museum (Natural History), 1950) [132

Joint Consultation a Practical Approach Pp 48 (London Institute of Personnel Management, 1950) *2s 6d* [132

Department of Scientific and Industrial Research Building Research Station National Building Studies, Technical Paper No 6 Investigations on Building Fires, Part 4, Fire Resistance of Timber Doors By C J Webster and L A Ashton Pp iv+20+3 plates (London H M Stationery Office, 1951) *1s* net [142

Forestry Commission Booklet No 3 Chestnut Blight caused by the Fungus *Endothia parasitica* Pp 4+4 plates *2s 6d* Britain's Forests—Tintern Pp 16 *9d* net Britain's Forests—Coed y Brenin Pp 16 *9d* net (London H M Stationery Office, 1950) [142

Furniture Development Council Technical Bulletin, Vol 1, No 1, January–February Pp 20 (London Furniture Development Council, 1951) 6 issues, *15s* [142

Department of Scientific and Industrial Research Report of the Geological Survey Board for the Year 1949 Pp ii+18 (London H M Stationery Office, 1950) *9d* net [142

Proceedings of the Society for the Study of Fertility No 1 Edinburgh Conference, 1949 Pp iii+44 (Cambridge W Heffer and Sons, Ltd , 1950) *10s* [142

Colonial Products Advisory Bureau (Plant and Animal) Consultative Committee on Insecticide Materials of Vegetable Origin Report of the Standing Sub-Committee on Methods of Analysis of Vegetable Insecticides on the World-Wide Collaborative Analysis of Pyrethrum Flowers, 1948–1949 Pp iv+64 (London Colonial Products Advisory Bureau, 1950) *4s* [73

Kirkstall Abbey Excavation First Report, 1950 By T A Hume and Dr D E Owen Pp 12+2 plates (Leeds Thoresby Society, 1951) *1s* [73

Department of Scientific and Industrial Research Radio Research Special Report No 20 Valve and Circuit Noise , a Survey of Existing Knowledge and Outstanding Problems Pp iv+19 (London H M Stationery Office, 1951) *9d* net [73

University of Cambridge School of Agriculture Memoir No 22 A Summary of the Papers published by the Members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct 1st, 1949–Sept 30th, 1950 Review Series No 5 A Survey of the Horticultural Research Station, 1922–1949 Pp 24 (Cambridge School of Agriculture, 1951) *2s 6d* [73

Commonwealth Economic Committee Industrial Fibres a Summary of Figures of Production, Trade and Consumption relating to Cotton, Wool, Silk, Flax, Jute, Hemp, Mohair, Coir and Rayon Pp xiv+149 (London H M. Stationery Office, 1951) *5s* net [73

Other Countries

Pubblicazioni dell'Università Cattolica del Sacro Cuore Nuova Serie, Vol 35 Contributi del Laboratorio di Psicologia, Serie quattordicesima Pp viii+387 (Milano Società Editrice 'Vita e Pensiero', 1950) 2,500 lire [181

United Nations Department of Social Affairs Bulletin No 4 Housing and Town and Country Planning Pp iii+121 (New York United Nations , London H M Stationery Office, 1950) 1 50 dollars , *11s* [181

Health Progress in the United States a Survey of Recent Trends in Longevity By Mortimer Spiegelman (National Economic Problems, No 439) Pp 28 (New York American Enterprise Association, Inc , 1950) 50 cents [181

Publications of the Dominion Observatory, Ottawa Vol 14 Bibliography of Seismology, No 7, Items 7222–7417, January to June 1950 By W G Milne. Pp 145–164 (Ottawa King's Printer, 1950) 25 cents [181

The Types of Symbiotic Linkage and their Significance for the Formation of Highly Organized Forms, Functions and Life Spheres in the Phylogenetic Process of Development By Prof Richard Falck Pp ii+18 (Jerusalem Research Council of Israel, 1950) 100 prutot [181

Publications of the Kapteyn Astronomical Laboratory at Groningen No 54 The Elements of the Eclipsing Binaries brighter than Photographic Magnitude 8 50 at Maximum By L Plaut Pp iii+78 (Groningen Hoitsema Bros , 1950) [181

United States Department of the Interior Geological Survey Bulletin 962-B Antimony Deposits of El Antimonio District, Sonora, Mexico By Donald E White and Reinaldo Guiza Pp iv+81–120+plates 13–25 70 cents Bulletin 976-B Geophysical Abstracts 141, April–June 1950, Numbers 11908–12125 By Mary C Rabbitt and S T Vesselowsky Pp iii+71–140 25 cents Water-Supply Paper 1068 Wells and Water Levels in Principal Ground-Water Basins in Santa Barbara County, California By G A LaRocque, Jr , and others Pp v+459+7 plates n p Water-Supply Paper 1072 Water Levels and Artesian Pressure in Observation Wells in the United States in 1946, Part 2, Southeastern States Pp vi+272 75 cents Water-Supply Paper 1085 Surface Water Supply of the United States, 1947, Part 5, Hudson Bay and Upper Mississippi River Basin Pp xii+479 1 dollar Water-Supply Paper 1093 Surface Water Supply of the United States, 1947, Part 13, Snake River Basin Pp viii+269 60 cents Water-Supply Paper 1114 Surface Water Supply of the United States, 1948, Part 4, St Lawrence River Basin Pp viii+296 65 cents Water-Supply Paper 1117 Surface Water Supply of the United States, 1948, Part 7, Lower Mississippi River Basin Pp ix+418 1 dollar Water-Supply Paper 1119 Surface Water Supply of the United States, 1948, Part 9, Colorado River Basin Pp ix+421 1 dollar Water-Supply Paper 1120 Surface Water Supply of the United States, 1948, Part 10, The Great Basin Pp vii+216 50 cents Water-Supply Paper 1121 Surface Water Supply of the United States, 1948, Part 11, Pacific Slope Basins in California Pp xi+449 1 25 dollars (Washington, D C Government Printing Office, 1949–1950) [122

Unesco List of Scientific Papers published in Latin America, 1949 Pp xlvi+506 Scientific Institutions and Scientists in Latin America Mexico, Vol 1 Pp ii+214 (Montevideo Unesco Centro de Cooperación Científica para América Latina, 1950) [132

United States Department of Agriculture Technical Bulletin No 1016 Vegetable Weevils and their Natural Enemies in Argentina and Uruguay By Harry L Parker, Paul A Berry and Aquiles Silveria Pp 28 (Washington, D C Government Printing Office 1950) 10 cents [132

Smithsonian Institution United States National Museum Bulletin 199 An Annotated Check List and Key to the Reptiles of Mexico, exclusive of the Snakes By Hobart M Smith and Edward H Taylor Pp v+253 (Washington, D C Government Printing Office, 1950) 75 cents [132

Kungl Lantbrukshogskolans Annaler (Annals of the Royal Agricultural College of Sweden) Vol 17 Pp vi+484 (Uppsala Kungl Lantbrukshogskolan, 1950) [132

Institut de France Académie des Sciences Annuaire pour 1951 Pp 238 (Paris Libr Gauthier-Villars, 1951) [132

Hyderabad Geological Series Bulletin No 7 Principal Clay Deposits of Hyderabad State Pp ii+52 (Hyderabad Government Printer, 1950) 2 4 rupees. [132

Administrative Report of the Government Museum Madras Pudukkottai Museum and the Connemara Public Library, Madras, for 1949–50 Pp 42 (Madras Government Printer, 1950) [132

Indian Forest Records, New Series Entomology, Vol 8, No 3 Larvae of Two Species of Anthribidae By Dr R N Mathur Pp 13–16+1 plate 5 annas , *6d* Entomology, Vol 8, No 2 Indian Longicorn Beetles (Coleoptera, Cerambycidae), Part 1 By J Linsley Gressitt Pp 9–12 4 annas , *5d* (Dehra Dun Forest Research Institute, 1950) [132

An International Bibliography on Atomic Energy Vol 1 Political, Economic and Social Aspects, Supplement No 1 Pp v+22 (Lake Success, N Y United Nations , London H M Stationery Office, 1950) *1s 9d* [132

Kgl Danske Videnskabernes Selskab Biologiske Meddelelser, Bind 18, Nr 12 Phytoplankton Studies, 1, *Nitzschia frigida* Grun an Arctic-Inner-Baltic Diatom found in Danish Waters By Jul Grøntved Pp 20+1 plate (København Einar Munksgaard, 1950) 12 D cr [132

Union of South Africa , Department of Education, Arts and Science Report of the Archaeological Survey of the Union of South Africa for the Period 1st April 1949 to 31st March 1950 (Annual Report No 15) Pp iii+8 (Pretoria Government Printer, 1950) [132

Water in Industry Pp 51 (New York National Association of Manufacturers, and the Conservation Foundation, 1950) [132

Smithsonian Institution United States National Museum Bulletin 50 The Birds of North and Middle America By Herbert Friedmann Part 11 Pp xiii+793 (Washington, D C Government Printing Office, 1950) 4 dollars [132

Canada Department of Mines and Technical Surveys Geological Survey of Canada, Memoir 256 Pleistocene Geology of the Lake Simcoe District, Ontario By R E Deane (No 2494) Pp vii+108+14 plates (Ottawa King's Printer, 1950) 1 dollar [132

Catalogues

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Mathematik, Physik, Chemie und chemische Technologie, Mineralogie, Geologie, Meteorologie, Astronomie, 1945–1950 Pp 32 (Wien Springer-Verlag, 1950)

Metropolitan-Vickers Gazette Vol 23, No 384, February 1951 Pp 297–320+xii (Manchester Metropolitan-Vickers Electrical Co , Ltd , 1951)

Mathematics, Statistics, Astronomy, Physics—Antiquarian, New and Forthcoming (Catalogue 636) Pp 94 (Cambridge W Heffer and Sons, Ltd , 1951)

Wild-Barfield Vertical Crucible Muffles (M 1050/V/2m) Pp 2 (Watford Wild-Barfield Electric Furnaces, Ltd , 1951)

TMC Technical Journal Vol 2, No 1, March 1951 Pp 36 (London Telephone Manufacturing Co , Ltd , 1951)

Rohm and Haas Reporter Vol 8, No 5, November–December 1950 Pp 22 (Philadelphia Rohm and Haas Company , London Charles Lennig and Co (Great Britain), Ltd , 1950)

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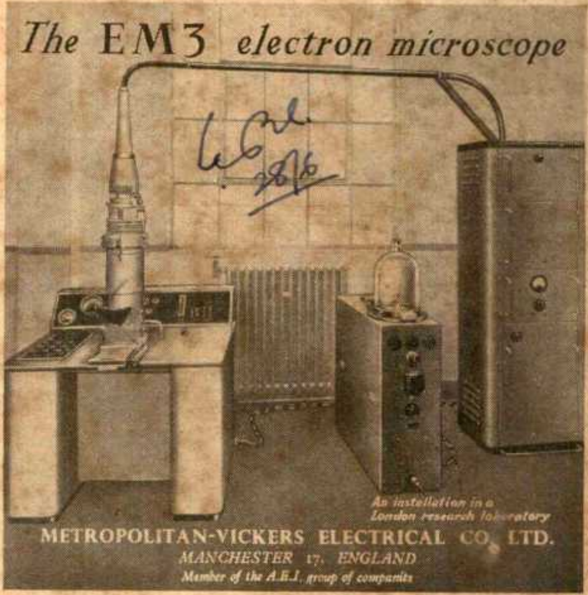
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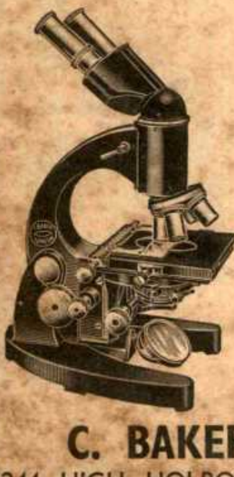
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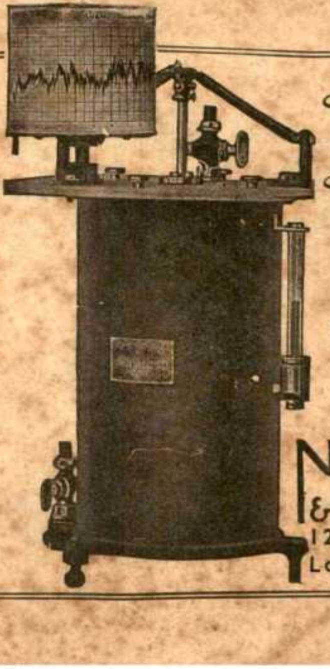
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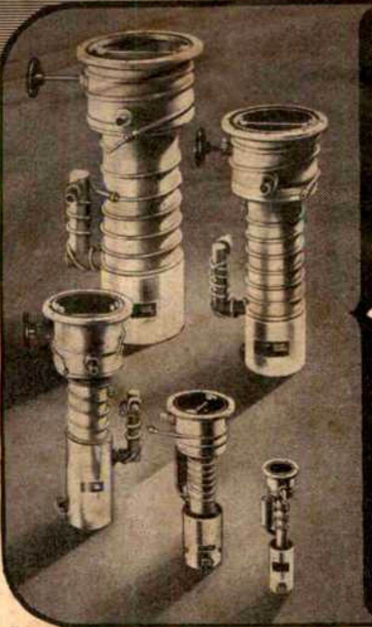

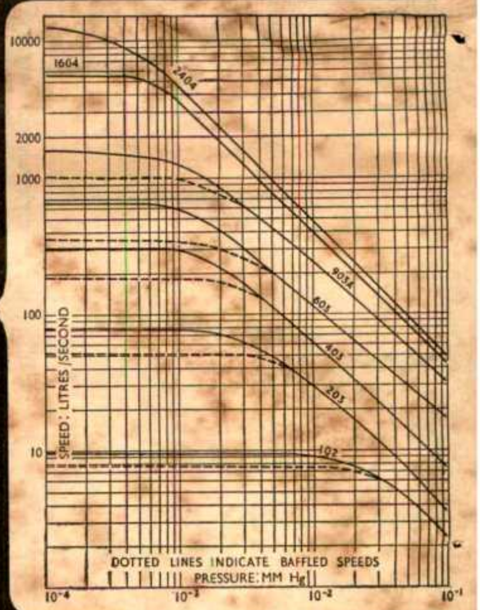

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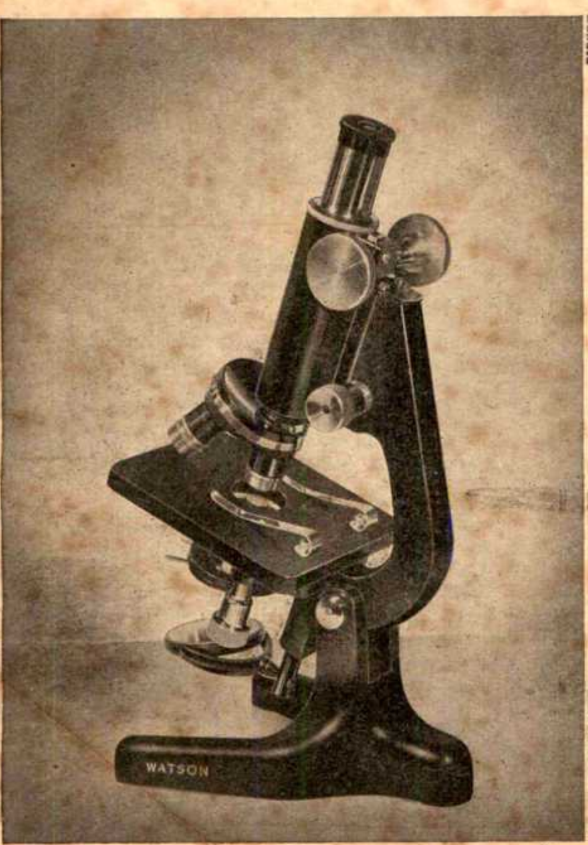

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The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad
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TECHNICAL AND TECHNOLOGICAL EDUCATION

IN view of the extent to which the Massachusetts Institute of Technology has figured in current discussions on higher technological education, the report of the Committee on Educational Survey to the Faculty of that Institute is of special interest The report has recently been summarized in *Nature* (167, 470, 1951), there are several features in it, however, which bear particularly on some aspects of higher technological education in Great Britain, and they can be usefully examined further The main report is supported, for example, by the report of a Committee on Staff Environment The former had recognized that the most effective teaching requires an environment which is stimulating and conducive to creative work on the part of the staff, and that the performance of an institution is determined ultimately by the quality of its staff, the latter examines what is required more specifically for the Massachusetts Institute of Technology

Much that is recommended in this latter report appears in general terms in the Barlow Report on Scientific Staff published in 1945, but the significance of the present report in relation to technological education in general is the strong support it lends to those who insist that the administrative side of the technical colleges in Great Britain precludes their development into the type of institution which can most effectively serve the needs of higher technological education The evidence of this report on this point is the more impressive because it is so independent of any possible bias as regards British institutions

Other features of the main report which bear particularly on the current discussion in Great Britain are the discussion of sponsored research and its effects, and the emphasis which the Committee places on the integration of professional and general education It considers that the education programme or policy of the Massachusetts Institute of Technology has at times been unduly vocational, and it is convinced that an appropriate balance is possible between a training in science and technology and a sound general education at the undergraduate level In fact, it believes that the general and the professional objectives should not be separated, and that in a four-year programme they can be combined to produce educated men with a sound basis for a professional career

This belief that sound judgment and creative imagination can be developed through the proper kind of study of professional problems in a professional atmosphere is clearly akin to the school of thought in Great Britain of which Mr Eric James is so able an expositor The insistence that the tendency to increase the extent of individual subjects should be resisted is also to be noted, and the observations on the need for undergraduates to have sufficient time for reflective thinking If these conclusions are sound, they point strongly to the appropriateness of developing technological education within the universities, rather than in separate institutions These views are, indeed, a return to the early ideals of the founder of the Institute, W Barton Rogers, but there is another comment of that period quoted in the report which is worth considering to-day C W Eliot was maintaining in 1869 that a technological school is best placed in a great industrial centre, where the professors of science have the opportunity of daily contact with practical affairs and of watching the day-to-day development of inventions If there is any substance for such a belief, the place for the expansion of technological education is in the appropriate departments of such universities

Some support is lent to this idea by the success which has attended the Institute of Paper Chemistry at Appleton, Wisconsin, the success of which has been attributed in part to its location in a compact area of diverse paper manufactures and paper-mill machinery manufacture unequalled elsewhere in the United States Here, however, so far as Great Britain is concerned, regard should be had to the research associations, the functions of which in supplying industry with trained men and women call for consideration also in the planning of technological education A free interchange or movement of staff between the research associations and industry and the universities is desirable from every point of view It may well be that the educational functions of the research associations will become of increasing importance, and that their participation in technological education, especially at the postgraduate level, might help to solve some of the difficulties in regard to equipment which hinder its expansion at the universities

The position of the research associations bears also on the question of sponsored research The Committee of the Massachusetts Institute of Technology fully recognizes the advantages to the Institute of a sponsored research programme, provided that staff and resources are not over-committed Against the advantages of closer contact of graduate students with real engineering problems, of the provision of special facilities that contribute to the advance of engineering knowledge, and of the support of fundamental scientific investigations which might otherwise be too costly to undertake, certain dangers have to be considered Not only may the technical staff of the Institute be occupied excessively with administrative activities, or attention diverted unduly from fundamental scientific inquiry, there is also risk of competition with industry, and of placing an excessive proportion of the Institute's finance on a short-term basis Moreover, the Committee regards the conduct at an educational institution of any research or development work that comes under secrecy regulations as undesirable These conclusions are largely those that have been reached independently in Great Britain as regards sponsored research at the universities

The recommendations that follow for efforts to increase the support of fundamental scientific inquiry, to broaden the basis of sponsored projects by increasing the industrial participation and continuing to refuse sponsored research primarily for profit or as a contribution towards salaries, are essentially designed to favour the maintenance of a balance between sponsored research and other activities, which will ensure that the Institute can adjust its policy more readily and independently to changes

This aspect is, however, scarcely considered in articles on British universities and research which appeared in the February issue of the *Universities Quarterly*, although one of them discussed technological research in the industries and another scientific research in the universities from the development angle In the first of these two articles, Dr N J Petch, after emphasizing the value of the work already done in the universities, stated that, from the point of view of technological research, expansion of the existing departments of technology is likely to yield a greater return on expenditure than the establishment of a new technological university, since in institutions of university type only a small proportion of the annual expenditure could go towards the actual cost of equipment The costliness of equipment for technological research is, of course, a prime difficulty in the expansion of technological education, and is one reason why some central planning of resources is unavoidable Even if the reinforcement of existing institutions and departments is more economical than the development of new ones, some selection is essential in order to avoid dispersal of effort and consequent inefficient use of expensive installations

To this end the co operation of industry and of the research associations may, as already noted, also be important, but responsibility for higher technological education and of university education by some one body of the type of the University Grants Committee is a first condition, and the very fair appraisal of the functions of the National Research Development Corporation which its technical manager, Mr M Zvegintov, contributes to this symposium confirms this impression There is clearly no thought of encouraging sponsored research, but it is at least possible that as the work of the Corporation extends and becomes better known, it may be able to make some contribution to technological education and research through its pilot-plant facilities It is a possibility that should be kept in mind, though it has evidently eluded both the Parliamentary Secretary to the Ministry of Education, as indicated in his reply on the debate on higher technological education on March 22, and also the Association of Technical Institutions and the Association of Principals of Technical Institutions in the "Statement of Policy on the Future Development of Higher Technological Education" which they prepared recently*

The debate initiated in the House of Commons by Mr Ralph Morley on March 22 did not provide quite the same condemnation of the recent report of the National Advisory Council of Education for Industry and Commerce as did the earlier debate in the House of Lords Mr H N Linstead, however, was severe enough in his strictures and urged the Minister to refer the report back to the Council with the comment that its recommendations do no more than touch unrealistically the fringe of the problem, and that it should now turn its attention to the problem of producing the right institutions in which the technologists of the future are to be trained Virtually the only supporter of the report was the Parliamentary Secretary to the Ministry, the other four speakers all showing a clear grasp of the difference between the technologist and the technician, even if they were unable to define the distinction, and an appreciation of the problems involved for both universities and technical colleges

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* Statement of Policy on the Future Development of Higher Technological Education Pp 15 Prepared by a Joint Committee of the Association of Technical Institutions (Hon Secretary, Polytechnic, Regent Street, London, W 1), Association of Principals of Technical Institutions (Hon Secretary, Technical College, Dudley)

To some extent Mr Hardman appeared to appreciate the issues also , but although he rightly referred to the importance of building on existing traditions, he showed no real appreciation of the importance of the staff factor, and the trend of his remarks about expansion of technological training in both universities and technical colleges is not reassuring. It suggests that there is real danger that, on one hand, the Ministry may disperse resources too widely— over technical colleges generally—to make any effective contribution to higher technological education, while at the same time the training of technicians may be seriously hindered Uneasiness on this score will be increased by the entirely misleading impression he gave of the amount of support which the Advisory Council's report has, in fact, received from responsible and disinterested opinion

It is all the more surprising to find that the Association of Technical Institutions and the Association of Principals of Technical Institutions accept the main recommendations of the Advisory Council's report, because their own Statement of Policy directs attention to some of the main weaknesses in the present position It is pointed out, for example, that the most serious problem associated with the development of higher technological education is that of staffing The recent awards have now freed local authorities from the restrictions imposed by the Burnham scales of salary, and they are now able to offer more attractive conditions if so disposed Whether they will do so without some change in the government of the technical colleges is clearly doubtful to the two Associations , but neither of the changes which the Statement of Policy suggests here s likely to contribute towards the atmosphere of freedom and independence which is as important as actual salary scales in attracting the right type of staff

The Statement of Policy shows a greater awareness of the needs of the technician than some other contributions to current discussion of the future of technological education , but the question of balance s ignored, and one might well have looked for some nore authoritative guidance on the difficult question as to whether higher technological education and echnical education can really be conducted with efficiency in the same institution The Statement, ndeed, illustrates the need for some independent body which will put the right questions to both university and technical college, and which is competent to allocate resources from a national point of view and uninfluenced by questions of local politics or professional rivalry. On some of the questions, it would appear that a more searching analysis of the actual facts is still required before a wise decision as to policy can be made.

"DOFLEIN'S PROTOZOA"

Lehrbuch der Protozoenkunde

Eine Darstellung der Naturgeschichte der Protozoen mit besonderer Berucksichtigung der parasitischen und pathogenen Formen Begrundet von Franz Doflein, fortgesetzt von Prof Dr Eduard Reichenow Sechste Auflage Teil 1 Allgemeine Naturgeschichte der Protozoen Pp iv+408 (Jena Gustav Fischer, 1949) 21 D marks

THIS sixth edition of Doflein's classic work, now being edited by Prof E Reichenow, is published twenty years after the fifth edition, which Prof Reichenow also edited and extensively revised Throughout all its editions, this book has been a fine example of the high standards of the house of Gustav Fischer, of Jena, which publishes it , and the fine printing and beautiful illustrations of the fifth edition will still entitle it to a place on the shelves of those who value a scientific book for the quality of its production as well as for its contents For, although the printing of this sixth edition is no less skilful, it has been handicapped by the quality of the paper used. The type is still clear and the illustrations still have their characteristic distinction and scientific value, but much of the æsthetic quality of the earlier editions has inevitably been lost

In other respects the book retains the authority communicated by Doflein to its first edition The plan of the first part of it is not changed, but careful revision is evident throughout Much of the text remains as it was , but many paragraphs have been rewritten, space has been saved by the use of small type for sections considered by the editor to be less important than others, and many interpolations help to bring the book up to date The illustrations, too, have been revised Some of the figures printed in the fifth edition have been omitted and new ones have been inserted Although there are nineteen fewer figures, the wealth of unexcelled illustration which has always been a feature of "Doflein" is retained to delight and instruct the reader

Criticisms of some of the views expressed will probably be made No one can write, or even edit, a book like this, which records and seeks to interpret so much detail and discusses so many fundamental problems, without initiating argument and controversy It is, indeed, remarkable that one man can still be found who has the ability and breadth of experience to compass so wide a field and to deal with so much variety of research It is an accomplishment that is inevitably becoming rare In Great Britain, where the protozoologist who studies more than the economic aspects of protozoology has never received sufficient encouragement, it has not been publicly recognized since King's College, London, enabled Minchin to found a tradition which has been unhappily allowed to die But "Doflein"—or, as it now is, "Doflein–Reichenow"—remains to exhibit to us the Protozoa, not only as causes of serious diseases of man and animals, but also as organisms of which the astonishing beauty and variety of form, physiology and adaptation pose for us unsolved problems of great biological importance It is a pity that a work like this, to which there is nothing comparable in other languages, has never been translated for the English-speaking reader. G Lapage

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SOUTH AFRICAN ALOES

The Aloes of South Africa
By Gilbert Westacott Reynolds. Pp xxiv+520+77 plates (Johannesburg Trustees of the Aloes Book Fund, 1950) 73*s* 6*d*

This sumptuous volume concerning a fascinating genus of succulents is the result of the labour of one who, to quote from the foreword written by the late General Smuts, "has explored almost every hole and corner of South Africa where Aloes grow" The author's indefatigable search for members of this genus has ensured a knowledge of the natural habitats of these plants and a familiarity with them in all their variations under their native environments that have produced a monograph of unrivalled reality

Moreover, the author's skill as a photographer both in colour and in black-and-white has resulted in a series of photographs of the species in their wild setting that will be the envy of those writing monographs on other genera

A group of this character can only be effectively studied by extensive field-work, and we have in this book the outcome of the effective combination of the results of the study of the growing plants with examination of herbarium material It is interesting in this connexion to note the author's comment "The more field experience and the nearer to Nature and instructive perception one can approach the more is one urged along the path of grouping within reason, rather than splitting' , or again, "some present day European workers have added to the confusion by erecting species and varieties on the flimsiest pretext with total disregard as to the manner in which Aloes grow and vary in their South African natural habitats"

The first part of the work is concerned with a brief account of the early travels in South Africa, but it was not apparently until 1674 that specific mention of these plants was made Later, in 1685–86, Claudius, who accompanied the expedition of Simon Van der Stel, painted four species of aloe Also, there is good reason for believing that at the end of the seventeenth century Oldenande had ten species of the genus in cultivation in the Gardens of the Dutch East India Company, but in general the earlier collections paid little attention to the aloes Historical notes are provided regarding a number of botanists that have contributed to the study of the genus, and of these some of the more notable in recent years have been Dr S Schonland (1860–1940), A Berger, Dr Pole Evans, N S Pillans, Dr F Z Van der Merwe, and last of all the author, Mr G W Reynolds himself, who, though not a professional botanist, has described no less than twenty-five new species besides several distinctive varieties

These historical notes, together with a short description of Bushman's paintings of two aloes, occupy the first seventy pages Bibliographical notes in the pre-Linnæan and later period are next considered (pp 71–96), and these together with brief accounts of taxonomy, a list of references and a table of flowering periods constitute the first part

The second part (pp 103–505) is devoted to the descriptions of the species themselves and their main varieties, all of which are illustrated in their native habitats either in black-and-white or colour, sometimes in both, and the individual flowers are shown natural size in various stages of development The colour plates illustrate no less than seventy-five species, three varieties and three hybrids

For every species the author provides bibliographical references, a detailed taxonomic description, an account of the type, locality and distribution, flowering period, and notes on variation and putative hybrids that throughout witness to a profound knowledge of the living plants One cannot, however, but regret the absence of distribution maps as a record of the author's unrivalled field experience which words alone cannot convey

The South African species here described number no less than one hundred and thirty-two, of which more than eighty are to be found in the Transvaal area Of the ten sections of the genus, two only have no South African representatives These are the section *Aloinella*, to which the dwarf Madagascan *A haworthioides* belongs, and *Sabœaloe*, of which the Arabian tree aloe, *A sabœ*, is the type The aloes range in height from dwarf species such as *Aloe albida* from the East Transvaal and *A saundersiœ* from Natal, both only about 15 cm in height, to large trees such as *A bainesii* that can attain 18 m The very distinctive *A polyphylla*, with its beautiful dense, almost spherical, rosettes of leaves like a glorified house-leek, one of the rarest species, is confined to a small area in Basutoland, while *A striata* with its coral-red flowers is equally noteworthy for the beauty of its inflorescence An unusual habit is represented by the scrambling *A ciliaris*, as also by *A suffulata* with a very slender inflorescence that obtains support from the bushes through which it scrambles, while *A mitriformis* has shoots that are prostrate extended rosettes

A more-or-less bulbous habit is exhibited by *A kniphofioides* and the Rhodesian *A bulbicaulis* Naturally, one thinks of such succulent plants in relation to dry habitats, and some of the aloes are extremely resistant to drought For example, *A krapohliana* grows in areas with an annual rainfall of less than 10 in , while the procumbent *A claviflora*, with its curiously oblique red inflorescences and 'fairy-ring' like growth, occurs in areas with a precipitation of less than 5 in , and Mr Reynolds mentions this species as frequently having to endure temperatures of more than 100° F But, at the other extreme, *A nubigena*, which is found on the precipitous faces of the Drakensburg at an altitude of about 4,700 ft , enjoys an annual rainfall of 75 in and grows in damp shaded situations within the clouds and the spray zone of a waterfall

The genus thus lacks neither morphological variety nor ecological interest, and this account is a monument to the assiduous labours of the author, who travelled more than a hundred thousand miles in search of his data and has provided in this book a beautifully illustrated record that will remain a classic monograph alike in its contents and presentation E J Salisbury

HEBRIDEAN LAMENT FOR A CHANGING WORLD

Afoot in the Hebrides

By Seton Gordon Pp 322 (65 plates) (London *Country Life*, Ltd , 1950) 30*s* net

SETON GORDON is by far the best known of writers on natural history, landscape and folklore of the Scottish Highlands and Islands, and his fund of knowledge of this paradoxical corner of the earth seems inexhaustible Here is a well-illustrated book devoted to the Hebrides and dealing particularly with legend, archæology, verifiable history and local anecdote, written in the author's unhurried style without plan or system There is a great deal of valuable record in this book, though any one fact would take a lot of finding, despite the index One does not grumble at this in a writer who has always gone his own way, and by whom we would always prefer to be entertained rather than be instructed

Because he is unique, we can bear that Seton Gordon should wear the rose-coloured spectacles, though he has had his imitators, who happily do not last It is amazing that he can wander still enchanted through this haunting and haunted land which is one of the most devastated areas of Europe One can read here incidentally of the burning of the forest on Raasay in the course of a Viking raid, but not of the immense ecological impact of forest destruction in the Highlands and Islands through a thousand years The Vikings began it, political feuds and iron-smelting continued it, the eighteenth century accelerated it, and the two World Wars of our own time finished it The "coming of the sheep" in the eighteenth century prevented the regeneration of forest, and the widening cattle/sheep ratio set in train a deterioration of the habitat which is to-day the root cause of the Highland problem and the basis of some of Seton Gordon's beautiful laments Let us enjoy this book unreservedly, putting it by the bedside and remembering the beauty of Nature and of human nature which the Hebrides reveal, but when we rise in the cold light of the morning we should not forget the terrible scourge of sheep and rabbit, and the loss of cover and absorbent mould which could deal with a hundred inches of rainfall A moor of *Scirpus* sedge in the dusk of an October day is indeed lovely it is then the deer's hair grass, an auburn pelage, but the ecologist who has delved deep enough sees it as a degraded biotic climax brought about by continuing misuse

The book is full of information of one sort and another of the ways in which a people meet the challenge of a difficult environment, for example, a Soay man going home lights a fire across the sound at Elgol in Skye—in the words of the country "puts up a smoke"—so that a boat shall put across for him But this is not all, he makes the fire on the knoll traditionally used by his family, and the right boat puts out The telephone could do little better and the smoke is cheaper At the other extreme, nobody could be more air-minded than the Hebridean, and the air ambulance is the accepted means of evacuating the desperately ill

There is also described that important social habit and conservation measure of going to the shieling It persists in Barvas, Lewis The younger folk go to the moors in May or June with the livestock, and the older people remain at the crofts to tend the crops until harvest Thus the herbage around the townships gets some respite, and the higher grazings are used The young population at the shielings enjoyed a freedom impossible in the presence of the old, for nowhere is the commandment to honour father and mother more scrupulously kept The demands of education cut across the desirable continuance of the shieling life, just as other exigencies of modern life render uneconomic those forms of cultivation in this countryside which helped in its conservation F FRASER DARLING

MICROSCOPY

Die Grundlagen der Theorie des Mikroskops

Von Dr Kurt Michel (Physik und Technik, Band 1) Pp xi+314 (Stuttgart Wissenschaftliche Verlagsgesellschaft m b H , 1950) 27 D marks

Le contraste de phase en optique et en microscopie

Par Maurice Françon Pp 109+6 plates (Paris · Éditions de la *Revue d'optique théorique et instrumentale*, 1950) 480 francs

Das Polarisationsmikroskop

Eine Einfuhrung in die mikroskopische Untersuchungsmethodik durchsichtiger kristalliner Stoffe fur Mineralogen, Petrographen, Chemiker und Naturwissenschafter im Allgemeinen Von Prof Conrad Burri (Lehrbucher und Monographien aus dem Gebiete der exakten Wissenschaften, 25 Chemische Reihe, Band 5) Pp 308 (Basel , Verlag Birkhauser, 1950) 32 80 Swiss francs

IN spite of all that has been written about the microscope, the increasing use of the instrument in numberless fields of inquiry has maintained a lively interest in its theory The development of dark-field illumination, followed by the introduction of phase-contrast methods and the still more recent electron microscopy, have created a new demand for exposition While the work of Helmholtz, Abbe, Rayleigh and others had laid the foundation on which a satisfactory theory could be constructed, it was only too clear that much remained to be done, and various writers such as A E Conrady and M Berek have striven to lay down principles for the guidance of practical workers It is probable that perhaps the majority of users of the instrument still have not sufficient acquaintance with the theory to attain either the best performance in operation or the best possible interpretation of the results Therefore, any modern book purporting to deal with the theory of the microscope will be greeted with considerable interest

Dr Kurt Michel, who collected the material for his "Die Grundlagen der Theorie des Mikroskops" during a ten-year period with the firm of Carl Zeiss (Jena), has had excellent opportunities of contact with such masters as A Kohler and others, and he approaches the topic mainly from the point of view of the physicist Two-thirds of the book is taken up with a very comprehensive review of basic physical and geometrical optics, vision (including colour vision), photography and the like The mathematics is limited to elementary algebra and trigonometry except for one or two simple integrals Good descriptions of the construction of various types of objectives, etc , are accompanied by aberration curves and much other information rarely found in books on the microscope The whole is illustrated by numerous very clear diagrams, some in colour

There are some minor errors (for example, the central foveal cones are well known to be much smaller than 5 μ), and there is some over-simplification The highly important dependence of visibility on contrast ought to receive adequate attention in any thorough discussion of the basic problems of microscopy, and would surely be much more valuable to the worker than the description of the supposed mechanism of colour-vision according to Studnitz, whose views are by no means so well accepted as the text seems to imply

The last part of the book is almost completely devoted to a painstaking discussion of the wave theory of optical image formation in the microscope, the distinction between the self-luminous and non-self-luminous cases being clearly drawn at the outset The cases chosen for mathematical discussion relate to the classical two-dimensional cases, so that simple sine functions rather than Bessel functions are encountered After the discussion of small apertures, the images of 'amplitude gratings' and 'phase gratings' are considered, and the various classical points of the Abbe principle are discussed in detail The theoretical aspects of phase contrast are dealt with in this connexion A section is devoted to the description of experiments of the type due to Abbe Perhaps the most interesting parts of these employ natural objects, that is, lycopodium spores The well-known experiments on *Pleurosigna angulatum* are not forgotten, and are illustrated by excellent photographs

Ultra-violet microscopy is dismissed in two pages, and a short section gives some information on the principles of electron microscopy Apart from the brief discussion of the theoretical aspects of phase contrast already mentioned, the matter is apparently not considered sufficiently important to be treated in any detailed manner Reflecting microscopes are not mentioned It will be clear that the author has probably not been in touch with the recent developments in microscopy outside Germany, which is a pity, since his remarks on them would have been worth reading Within its limits, however, the work is a good contribution to the literature of the subject, and there are few who will not find within its pages useful additions to their knowledge

The second work, namely, M Maurice Françon's small book on phase contrast, is addressed to quite another class of reader and is mainly concerned with a concise presentation of the mathematical diffraction theory of phase-contrast and other allied methods It can be recommended to those who wish to lay a sound foundation for further theoretical or experimental researches, though it is not intended for those who merely need an easy explanation or introduction to the experimental aspects of the subject The book includes, however, brief descriptions and theoretical discussions of a number of experimental methods which are still little known, including such devices as M Françon's own arrangement of the auxiliary hemisphere, the Lyot compensator, and various forms of polarizing phase-plates

The diffraction theory leads, of course, to various more or less complex formulæ which can usually be interpreted only by numerical calculations A great many curves illustrating such results are given in the text, but, while they are indispensable in obtaining a rational approach to the matter, it has to be confessed that many simplifying assumptions are necessary, and we are still a great distance from the point at which empirical methods in actual phase-contrast microscopy can be abandoned. Apart from this, however, special measurements, such as Françon and Taboury's estimation of the thickness of a monomolecular film of fatty acid, are now possible, they represent a considerable advance on the limits traditionally assigned to purely optical methods

Much of the work described in the book is necessarily a preliminary study and thus suffers somewhat from brevity and occasional over-simplification For example the criterion of resolution, that is, the vanishing of the second derivative of the intensity curve at the mid-point in the line joining the images of two objects, may be admitted to apply to the case of actual luminous points, but surely, in discussing the resolution of the phase-contrast images of small depressions, etc, the criterion should not be applied without a discussion of the contrast of the whole image ? A considerable amount of work is still required before any generalizations are admissible M Françon's work represents, however, an important stage in the development of the subject, and physicists will be grateful for this excellent monograph

Prof Conrad Burri's book on the polarization microscope is written with the intention of finding an acceptable compromise between the type of book which is mainly descriptive and qualitative and the immensely sophisticated mathematical treatments of the optics of crystalline media which bear small relation to practical requirements. The days are past when this subject was scarcely of much importance to those other than petrologists, the author remarks in his preface that ninety per cent of the students taking the introductory courses on the polarization microscope are chemists and biologists. Thus the whole treatment is conceived from a very general point of view The mathematics required, however, scarcely ever goes beyond trigonometry and a few formulæ in analytical geometry, the results of any long analysis being quoted where necessary. It is characteristic that a discussion of the analysis of elliptically polarized light should find an early place The book then proceeds to a very thorough description of the "Optical Indicatrix" and its applications There is then a very thorough discussion of the polarization microscope and its accessories, and further sections deal with the principal experimental techniques

Prof Burri has had considerable help in the preparation of the book from the late Prof M Berek, of Wetzlar, whose death in October 1949 deprived the world of science of an important leader in the field of microscope optics, some details, due to Berek, have not been previously published elsewhere

The book is lavishly illustrated by excellent line diagrams and half-tone blocks, and is altogether most attractively produced Prof. Burri has not only taught practical classes in this subject for more than twenty years, but also has obviously spared no pains to keep himself informed of the latest developments, so that the book will be a very useful one to any teacher or advanced student of the practical sides of the subject Perhaps a physicist, approaching the subject with a reasonable mathematical equipment, might have been grateful for a few mathematical appendixes giving the derivation of some of the formulæ, since even in the books on theory there is a gap between the cursory treatment in the average book on light and the very full discussions already referred to However, it is clear that this volume will be a welcome addition to the literature available

L C MARTIN

DATING LATE-PLEISTOCENE EVENTS BY MEANS OF RADIOCARBON*

By Prof RICHARD FOSTER FLINT
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GEOLOGISTS concerned with the Pleistocene epoch have made repeated attempts to determine the time elapsed since the occurrence of conspicuous events in Pleistocene history Most attempts have consisted in extrapolating backward on the rates of processes that are still in operation However, as each of these rates is variable, the estimates have involved errors that are uncontrolled and perhaps very large Nevertheless, there has been apparent the human tendency to remember the figures while forgetting that they are only estimates

The situation has been changed by radiocarbon, through a method developed by Libby and Arnold[1] at the University of Chicago By means of this method, it has become possible to date certain kinds of fossil substances, and thus to date the stratigraphic horizons from which they were collected The method is limited in total range, and is subject to certain errors, but it represents a long step forward

Origin and Nature of Radiocarbon

Radiocarbon (^{14}C) is a radioactive isotope of carbon It is produced in the upper atmosphere by the bombardment of atmospheric nitrogen by cosmic-ray neutrons It reacts with atmospheric oxygen to form carbon dioxide, and in that form enters into all organic matter, as well as into all material exchangeable with atmospheric carbon dioxide, such as carbonate in sea water

If it is assumed that the flux of cosmic rays has been uniform throughout the past 15,000 years or so, then the proportion of carbon-14 to carbon-12 on the earth—about one to one trillion—should be constant, because the rate of disappearance of carbon-14 through radioactive disintegration and the rate of its creation should have struck a balance It is probable, further, that the ratio of carbon-14 to total carbon in living matter must be constant, because the carbon in organisms is in continuous exchange with atmospheric carbon The probability of the constancy of these proportions is supported by analyses of living matter taken from various latitudes

On the death of any organism, this steady state of exchange ceases The carbon-14 in the organic matter is diminished, by its own radioactive disintegration, at a known rate, and is no longer replaced by fresh accessions as was the case during the life-time of the organism Hence the specific activity of the carbon in the dead organic substance gradually diminishes below that of the carbon in living matter The half-life of carbon-14 is 5,568 ± 30 years If the specific activity of the carbon in dead organic matter is determined to within a small limit of error, from it the time elapsed since death can be calculated Whether the dead organic matter consists of charcoal from a prehistoric hearth, peat from a postglacial bog, or a tree over-ridden by a former glacier, the resulting dates, if accurately determined, are of the greatest importance to geological and human history.

The short half-life of radiocarbon limits the backward reach of the dating method At the end of three half-lives, the specific activity of the element has become so small that it is difficult to measure it accurately Hence, at present 20,000 years is the effective limit of the dates determined by radiocarbon There is hope, however, that through an enrichment process now under development this limit can be increased considerably

Method of Assay

The samples are collected with care, so as to ensure minimum contact with other carbon-bearing substances If the material is wood or other plant matter, the sample must weigh at least 40–50 gm when dry It is converted to carbon dioxide by burning (thereby eliminating other radioactive elements) After further purification the carbon dioxide is reduced to carbon by burning with metallic magnesium

The carbon is placed in a tube in a screen-wall counter having an elaborate system of shields, and its specific activity is determined automatically The elapsed time since death is then computed from the value of the specific activity Laboratory error varies with the time devoted to the counting process , in many of the samples determined it is less than 5 per cent

The laboratory process is checked from time to time by assaying anthracite coal, which, being of the order of 250 million years old, has no appreciable specific activity. Negative results from assay of the coal indicate that no laboratory error caused by contamination has developed The method was checked also by testing samples of ancient carbon-bearing materials of known dates, such as wood from dated Egyptian tombs, and 'dead' heartwood from ancient trees dated by growth-rings The laboratory dates agree well with the dates earlier determined by other means

The dating method developed by Libby, Arnold and their associates at the Institute for Nuclear Studies in the University of Chicago, with financing in part by the Viking Fund, is still in an experimental phase During the past year it has progressed from the testing of knowns to the assay of unknowns When the need for ancient materials for assay was felt, a committee was appointed jointly by the American Anthropological Association and the Geological Society of America to work with the discoverers of the method The committee consists of Frederick Johnson (chairman), Donald Collier and Froelich Rainey as anthropologists, and R F Flint as geologist This group has been active in procuring material and as a consultative body, a screening and priorities board for incoming samples

Possible Errors

Collaboration between the laboratory and the committee has led to a better understanding of the various sources of possible error, from the collecting onward to the final counting process These sources now appear to be at least six in number

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* Abstract of a lecture given at University College, London, on February 22

(1) Possible variation in the rate of cosmic radiation during the time period spanned by radiocarbon dating However, the agreement between the radiocarbon dates and the historical dates of materials from ancient Egypt suggests that there has been no significant variation during the past 4,600 years

(2) Error in the field, in fixing the true stratigraphical position of the sample Here the laboratory results can act as a check on the field-worker

(3) Post-depositional alteration in the ratio of radiocarbon to total carbon, by chemical exchange and by organic activity, including penetration by roots of modern plants Unburned bone has given variable results, it is believed to exchange carbon easily while lying buried in the ground In contrast, 'burned bone'—essentially charcoal, and almost indestructible chemically—has given consistent results Carbonate in the form of shells has yielded results of varying accuracy, evidently owing to chemical alteration However, experience with shells has not been extensive, and the possibilities of their use seem by no means exhausted Wood and peat have given consistent, reliable results, regardless of whether samples had been collected from positions that were wet or dry

(4) Pre-depositional variation in the ratio of radiocarbon to total carbon For example, aquatic plants that derive their carbon in part from freshly dissolved ancient carbonates containing carbon-14 with diminished specific activity might yield falsely low age values

(5) Contamination during or after collecting

(6) Laboratory error, including contamination, counting, and mislabelling

If we set aside unburned bone and shells, and consider only the wood, peat and organic mud that constitute most of the geological specimens assayed before the end of 1950, the resulting dates fall into the same relative position as the stratigraphical horizons from which the samples were taken This could scarcely be the case unless the error involved in post-depositional alteration is of relatively minor importance

General Results

At least three general results are embodied in the dates obtained thus far from samples of primarily geological character (*a*) Most of the radiocarbon dates support the relative stratigraphical positions of the samples This encourages belief in the reliability both of the laboratory method and of the stratigraphical determinations made before the laboratory work was undertaken (*b*) The dates of events late in the Fourth Glacial age have proved to be much less than had been previously estimated or assumed (*c*) Climatic changes in northern and western Europe seem to have coincided approximately with those in North America

Two Creeks Horizon Perhaps the most important radiocarbon date thus far obtained is that of the Mankato, the latest of the four glacial expansions that occurred during the Wisconsin (Fourth) glacial age in North America This involves the Two Creeks horizon, a layer of peat and wood that separates the highest or Mankato glacial substage from the next-lower, Cary, substage The peat layer is exposed in wave-cut cliffs of Lake Michigan in northern Manitowoc County, Wisconsin, about twenty-five miles inside the outer limit of the Mankato drift According to meticulous studies made by Wilson[2], the peat, which is very thin, overlies varved sediments deposited in the glacial ancestor of Lake Michigan during Cary time The peat is overlain successively by more lacustrine sediments and by Mankato till Therefore the peat is post-Cary, but antedates the Mankato maximum The entire section seems to record continuous deposition, without any erosional hiatus

The peat represents a spruce bog, with ecological relationships similar to those found to-day in northern Minnesota, some two hundred miles north of the Two Creeks locality The spruce wood occurs as stumps rooted in place and as logs splintered at their butt ends and lying pointing towards the south-west, the direction of flow of the Mankato glacier The splintering is of the kind characteristic of green wood, hence the forest was living up to the time when it was destroyed Many of the logs record, through their growth rings, a decrease in rate of growth during the last few years of their lives

The implied sequence of events is as follows Late in Cary time the ice sheet shrank back, its southern edge bathed in lake water that occupied the basin of Lake Michigan as rapidly as the glacier uncovered it When the glacier shrank back north of the Strait of Mackinac, the lake in the Michigan basin was at least partly drained—enough for the Two Creeks locality to emerge Thereupon a spruce forest took root After a time of growth, the forest was flooded by a new lake ponded in front of the advancing ice, and within a few years the glacier itself arrived on the scene, overwhelmed and splintered the forest by a giant process of bulldozing, and buried the site beneath till as the glacier margin advanced to its extreme limit twenty-five miles beyond Two Creeks This was the Mankato advance

The whole sequence from Cary lake deposits through spruce forest to Mankato till, appears to be conformable It represents an interval of possibly no more than a few hundred years Both the implied short interval and the ecology of the bog suggest that deglaciation was not extensive, the ice-sheet margin may have retreated no farther north than the sites of the northern shores of the existing Great Lakes

The radiocarbon dates of five samples of logs, stumps and peat agree closely enough at an average figure of 11,400 ± 350 years Hence, the Two Creeks horizon, being closely fixed stratigraphically as representing the Cary–Mankato interval, and being also closely fixed in time, can properly serve as a key horizon to which other features can be related For this reason its date appears as the most important of this first group of radiocarbon results

The Mankato maximum must be younger than the time of destruction of the spruce forest by the number of years required for twenty-five miles of glacial advance This can only be estimated, an estimate of 200–400 years seems reasonable, giving us a round figure of 11,000 years for the Mankato maximum As the position of the Mankato drift border is known throughout an east–west distance of more than a thousand miles, the date of the Mankato maximum is widely useful

Allerød Horizon The very late Pleistocene horizon known as Allerød, occurring in many European peat bogs and lake deposits, gives evidence through its content of fossil pollen that it represents a time of warmth separating two colder times, and so by inference a time of glacial retreat, although unlike the Two Creeks peat it is not covered with till. It underlies Zone III of the pollen stratigraphers. Thanks to H. Godwin and F. Firbas, it was possible to determine the radiocarbon dates of samples of the Allerød from four localities in Ireland, England and Germany. The dates are fairly close together, with an average of 10,767 years. This figure is close enough to the Two Creeks date to suggest that Allerød and Two Creeks represent a single warm phase that was felt on both sides of the Atlantic Ocean.

Pine-Pollen Zone in Eastern United States. The best marked and most widespread of the layers that constitute the pollen-stratigraphical sequence in North America is Zone *B*, a pine zone, overlying spruce and fir, and generally underlying oak and other deciduous types. It represents the earliest post-glacial development of a warm and fairly dry climate. Following the shrinking ice sheet, this zone should be of progressively younger age with increasing latitude.

Radiocarbon dates on five samples assembled by E. S. Deevey, jun., confirm this deduction. Three of them constitute a sequence on the Atlantic slope:

Location	Date (round numbers)
Cranberry Glades, West Virginia	9,500 years
New Haven, Connecticut, about 400 miles farther north	8,300 ,,
Aroostook County, Maine, about 400 miles still farther north	6,000 ,,

The other two samples constitute a sequence in Minnesota:

Anoka, near Minneapolis	8,000 years
Ely, 220 miles north-east of Anoka	7,100 ,,

It is interesting to note that all five samples post-date the Mankato maximum.

Glacial Great Lakes. Another group of three samples, which also postdate the Mankato maximum, are related to each other because of their relationships to the glacial Great Lakes. They provide dates for events late in the history of those Lakes.

The first sample is charcoal from a human occupation site in an island in Cayuga Lake, New York State. The site could not have emerged until well after Lake Iroquois, a glacial lake occupying the Lake Ontario basin, had begun to be drained. Geological evidence shows that Lake Iroquois was drained while Lake Algonquin III still occupied the western or upper Great Lakes region. Hence it is likely that at the time of the charcoal, 4,930 ± 260 years ago, Lake Algonquin III, with its northern shore of glacier ice, was still present.

The second sample is peat from beneath the surface of the present-day Lake Superior, near its western end. It is believed to have accumulated in a lagoon of the early phase of the Nipissing Great Lakes. The body of water would then be dated by the peat as having been in existence 3,656 ± 640 years ago. Subtracting this figure from the date of the charcoal, we get a difference of 1,274 years, the minimum elapsed interval between a time when Lake Algonquin III existed and a time early in the history of the Nipissing Lakes.

The third sample is a piece of an oak log occurring as driftwood in emerged beach sand and gravel, south of the city of Chicago. At this locality there is a complex of ancient beaches, all within a vertical range of about ten feet, representing three known lake-levels of different ages: (1) the Toleston strand-line of Lake Chicago, (2) the latest strand-lines of Lake Algonquin III, and (3) the latest strand-lines of the Nipissing Lakes.

The radiocarbon date of the wood, 3,469 ± 230 years, helps to fix the correlation of the enclosing beach. The date is far too young for Toleston Lake Chicago, which long antedates Lake Algonquin. It is also too young for Lake Algonquin III, dated by the charcoal as 4,930 years. It is slightly younger than the early Nipissing phase measured by the peat sample. Of the three geological possibilities, therefore, radiocarbon indicates latest Nipissing as the probable age of the beach containing the driftwood log.

Subtracting the late Nipissing date from the early Nipissing date, we get 187 years as the time elapsed between them. If this seems short, we can take advantage of the specified errors in each of the dates, and thus obtain more room. Without doing this, we have:

Late Nipissing	3,469
Early Nipissing	3,656
Algonquin III (= Iroquois in part)	4,930
Toleston Lake Chicago (= Mankato maximum ?)	11,000 ?

This scheme rests only on four dates, and certainly must be regarded as tentative. However, the facts that two of the dates fit stratigraphical correlations made earlier, and that a third date closely fits one of the three possible correlations offered, encourage the belief that both the geological field-work and the radiocarbon dating are reliable.

If a number of successive strand-lines can be dated by means of driftwood, it may become possible to measure the rate of uplift of the crust as it responded to the removal of the great weight of the ice sheet.

Mt. Mazama. Crater Lake, in southern Oregon, occupies a great caldera created by the gigantic explosion and collapse of the former volcanic cone known as Mt. Mazama. The catastrophe had been estimated by geologists to have occurred about ten thousand years ago. The radiocarbon date of charcoal from a tree killed by the catastrophe is 6,453 ± 250 years. Thus it appears again that, if we accept the radiocarbon dates, earlier geological estimates have been too high.

Folsom Man. The Folsom culture, represented by no human fossils but by an abundance of stone dart-points of a peculiar type, has been recognized throughout a wide region in western North America. Estimates of the date of this culture have ranged up to more than 25,000 years.

The radiocarbon date of a piece of burned bone from an occupation site in the western part of the State of Texas, said to be associated with Folsom dart-points, is 9,883 ± 350 years. If accepted, this date would place Folsom man as having been in existence at a time slightly later than that at which the ice sheet, farther north, reached its Mankato maximum.

Lascaux Cavern. The Cavern of Lascaux, lately discovered in the Dordogne district of western France, with its outstandingly fine wall frescoes, has yielded one radiocarbon date. Charcoal collected by the Abbé Breuil and S. Blanc from beneath the floor of a low-level chamber was identified as having been derived from wood of the silver fir, which implies a cold-temperate climate. Associated with the charcoal were artefacts which competent opinion placed as not younger than Magdalenian II[3]. The radiocarbon date of the charcoal is 15,516 ± 900 years

Conclusion

If supported by further work, the results obtained thus far from radiocarbon dating constitute perhaps the most important event in Pleistocene research since the recognition of multiple glaciation and the establishment of a pollen stratigraphy. The examples[4] mentioned above are samples of the kind of result radiocarbon dating can accomplish. Radiocarbon can supply the dates of glacial advances and of climatic changes recorded by pollen frequencies; it can establish intercontinental correlations; it can date a sequence of strand-lines or a volcanic eruption; and, of perhaps greatest human interest, it can provide a firm chronology of ancient man. The universal importance of radiocarbon dating lies in the two facts that such dating is *absolute* and *world-wide*.

The Geochronometric Laboratory, now being set up at Yale University with funds provided by the Rockefeller Foundation, expects soon to begin a systematic programme of dating by means of the method pioneered by Libby and Arnold.

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[1] For example, Arnold, J. R., and Libby, W. F., *Science*, **110**, 678 (1949); **113**, 111 (1951), and references given there.

[2] Wilson, L. R., *Torrey Bot. Club Bull.*, **63**, 317 (1936), and references cited there.

[3] Oral communication from the Abbe Breuil.

[4] These examples and many others are discussed more fully in Flint, R. F., and Deevey, jun., E. S., *Amer. J. Sci.*, **249**, 257 (1951).

CREEP-RESISTING ALLOYS FOR GAS TURBINES

On February 22 and 23, a symposium on "High-Temperature Steels and Alloys for Gas Turbines" was held under the auspices of the Iron and Steel Institute in the rooms of the Institution of Civil Engineers in London. On the evening of February 21, Sir Frank Whittle had given the fifth Hatfield Memorial Lecture on the development of the aircraft jet engine, and the symposium provided an opportunity of reviewing the metallurgical progress to which his invention gave rise, and discussing the problems of the gas turbine at its present stage of development.

Sir Andrew McCance, past-president of the Iron and Steel Institute, in a brief introductory speech, emphasized that materials capable of withstanding stress at the highest possible temperature are essential for the improvements in the efficiency of the use of fuel that are vitally important for our economy. Mr. D. A. Oliver then occupied the chair. The opening paper of the symposium, by Dr. N. P. Allen, described the early history of the creep-resisting alloys, and gave an account of the efforts that were made between 1939 and 1945 in Great Britain, Germany and the United States of America to produce the alloys of which the jet engines were ultimately made. The subsequent papers, of which there were thirty-six, were devoted to British activities during and after the War, and are an invaluable source of information on all aspects of the subject. The meetings were well attended. The presence of a large group of foreign experts testified to the regard in which British work on gas turbines is held. It was pleasant to hear from the Swiss turbine builders of the reliance that they place upon materials supplied from Great Britain, and the forthright and informative contributions of the American speakers were very welcome.

There are now four principal classes of creep-resisting alloy. The austenitic nickel–chromium steels hold pride of place. They are separating into three types. When large forgings are required, and strength must give place to ease of production, a steel with about 18 per cent of chromium, 8 per cent of nickel, 1 per cent of niobium and 0.1 per cent of carbon is favoured. Much attention has been given to the properties of finished components, as distinct from the properties of experimental test bars, and the papers by Mr. H. W. Kirkby and Dr. C. Sykes gave unique and important information. The niobium for this steel is expensive, and becomes increasingly difficult to obtain. 'Austerity steels', in which the niobium is presumably replaced by a more abundant element having a similar effect, are being studied; but their compositions are not yet announced. For large castings, a steel with 25 per cent of chromium and 12 per cent of nickel tends to be preferred, as it solidifies with a partially ferritic structure and is more plastic just below the melting point than a fully austenitic steel. It is consequently easier to cast and weld. This steel contains carefully adjusted proportions of carbon, silicon and tungsten. Their importance was described in an interesting paper by Mr. J. I. Morley, which showed how, if the ferritic structure is too stable, the steel has low creep resistance and tends to form the brittle sigma constituent on cooling; whereas if the ferritic structure is not allowed to form, the steel has high creep strength but may contain brittle carbide networks. An intermediate condition is generally best, and may be varied slightly in one direction or the other according to the relative importance of creep resistance and toughness in the casting.

When the greatest creep resistance is necessary, the austenitic nickel–chromium steels are strengthened by additions of cobalt, molybdenum, niobium or titanium. The alloys made in this way can be hardened by precipitation, and complex heat-treatments are an essential part of their manufacture. They are also capable of improvement by suitable mechanical working. A detailed account of the 'warm working' process as applied to a typical steel of this class was given by Mr. G. T. Harris and Mr. W. H. Bailey, who showed how the amount of mechanical work and the temperature at which it is applied can be controlled so as to produce a material having both a high proof stress at the low temperature existing at the centre of a turbine disk, and a good resistance to creep at the high temperature existing at the rim. The iron in this class of alloy can be replaced by cobalt, with progressive improvement of the creep resistance. Mr. G. T. Harris and Mr. H. C. Child described how by systematic exploration an optimum alloy may be developed; but this alloy contains 45 per cent of cobalt, and the use of so much cobalt may be difficult to justify.

At present, when creep resistance greater than can be produced in austenitic steel is required, nickel–chromium alloys, precipitation-hardened with titanium and aluminium, are used. The work leading to their development was described for the first time in a paper by Dr. L. B. Pfeil, Dr. N. P. Allen and Mr. C. G. Conway. These alloys are well established in Great Britain, and their strength and freedom from exceptionally scarce elements suggest that they will maintain their place. They have been tested for periods up to ten thousand hours whether they will maintain their superiority for longer periods, up to a hundred thousand hours, is still open to question, and designers wish to be assured on this point A hundred thousand hours have not yet passed since the alloys were first conceived, and they have since undergone many minor changes The turbine designer is faced with the choice between materials that have been completely tested, and are therefore at least ten years old, and materials that are more recent, probably better, but less completely known His desire for more information and for means of predicting the behaviour of alloys in the distant future is understandable, but there is no reliable way of making forecasts Since there must be some limit to the amount of creep testing that can be done, it is very important to decide how much of the available effort should be devoted to the detailed testing of existing alloys, and how much to making the improvements that are surely possible

Ferritic steels are used when the service temperature is not so high as to demand austenitic steels Two types, containing respectively 0 5 per cent of molybdenum and 0 25 per cent of vanadium, and 3 per cent of chromium, 0 6 per cent of molybdenum, 0 8 per cent of vanadium and 0 6 per cent of tungsten, have received special attention, and have excellent creep resistance at temperatures below 600° C Extensive tests on the latter steel were reported by Mr H H Burton, Mr J E Russell and Mr D V Walker A very recent development is the introduction of creep-resistant ferritic steels containing 10–13 per cent of chromium These steels are resistant to oxidation, and therefore can be used at temperatures above 600° C, at which other ferritic steels fail. They compare very favourably in creep resistance at 600° C and 650° C with the first of the three above-mentioned classes of austenitic steel and, since they are more economical in alloying elements, may well replace them in some directions It is curious that no highly creep-resistant steel has yet been developed with a chromium content between 3 and 10 per cent, although steels with 5 per cent of chromium are quite resistant to oxidation and would be very economical to use if the necessary high-temperature strength could be developed An interesting paper by Mr. E W Colbeck and Dr J R Rait suggested that the carbides found in steels of intermediate chromium content are not of a type favourable to creep resistance, but this may not be an insuperable obstacle

The fourth type of creep-resisting material now in use comprises the range of cobalt-base precision-casting alloys These alloys, which usually contain about 30 per cent of chromium and a moderate percentage of either tungsten or molybdenum, did not figure in the symposium as much as might have been expected They are very costly, and although the results obtained in laboratory tests can be excellent, the alloys are not widely used for highly stressed components because of the difficulty of being certain of the reliability of castings In Great Britain precision casting has been used principally as a method of making lightly stressed components, such as stator blades, in oxidation-resistant but relatively economical alloys

A number of papers dealt with the problems of fabricating creep-resisting alloys, and it is clear that as much work has been required in solving these problems as in developing strength at high temperatures We are, indeed, in the process of building up a workshop technique for creep-resisting alloys comparable with that which has been developed for the common engineering steels during the past hundred years The gas turbine being built up of a series of rings, centrifugal castings have played a large part in its construction, and a rivalry between the centrifugal processes making use of metal moulds and those making use of sand moulds became apparent, the arguments being generally in favour of the use of the metal mould when applicable Precision casting processes are used for a variety of smaller shapes The processes are interesting as being a revival of the ancient lost-wax process They differ from the ancient process in being adapted, by an elaborate procedure, to the production of a large number of accurate replicas of the pattern, and in the use as mould materials of special refractories that can withstand the chemical attack of molten alloys at very high temperatures

In the construction of large gas turbines for marine engines and electric generators, the arc welding of austenitic steel forgings and castings has proved difficult, and many references were made to the danger of cracks in welds The cracks can be avoided by the use of suitable techniques and by the control of the silicon content of the weld metal There is uncertainty about the mechanical properties of arc welds at high temperatures, though such information as exists is reassuring The construction of flame tubes, jet pipes and ducts of many kinds in both austenitic steel and nickel–chromium alloy sheet has been accomplished by resistance welding with great success As described by Mr H E Lardge in a very informative paper, the distortion due to the high thermal expansion and low thermal conductivity of the alloys was overcome by welding with the smallest input of heat, and using effective means of cooling The machining of creep-resisting alloys at first presented great difficulties, which were overcome by the skill and resource of the men in the machine shops, to whom the gas turbine owes a great deal

The modern gas turbine has an inlet gas temperature of 650–800° C or perhaps 850° C Its thermal efficiency is rather low, and could be improved if the gas temperature were raised Naval representatives at the meeting emphasized that higher efficiencies must be developed before gas turbines can be widely adopted in ships The materials necessary to make higher working-temperatures possible are not yet in sight Cobalt–chromium–tantalum alloys having promising strength at 900° C were described by Mr J C Chaston and Mr F C Child their use seems to be impossible under present economic conditions, but it must be remembered that several of the alloys that are now in use would have been considered fantastically expensive twenty years ago Chromium-base alloys have been studied by Mr E A G Liddiard and Dr A H Sully They are too brittle, and no way of making chromium sufficiently tough has yet been found Excessive brittleness also prevents the use of refractory oxides such as sintered alumina It seems to be generally agreed that a certain amount of plasticity is essential in any practical material, as a protection against thermal shock, which can be very severe, and against excessive stress concentrations at changes of section 'Ceramels', which are mixtures, made by the methods of ceramics, of refractory oxides or carbides embedded in a metallic base, were considered by some authorities to offer the most promising combination of properties One speaker described engine tests on turbine rotor blades made of a ceramel consisting essentially of titanium carbide bonded with nickel or cobalt, in which the creep resistance of the material had proved to be adequate, but failure had resulted from insufficient resistance to the stress concentrations in the blade root. Confidence in this type of material has not yet been established, and its future seems to depend on the achievement of sufficient plasticity without loss of creep resistance.

The alternative way of achieving high inlet gas temperature is to cool the critical metal parts. The problem then is to secure the greatest effective cooling with the least loss of heat and energy in the cooling agent. There is little doubt that the most effective device is to interpose a stable blanket of cool gas between the hot gases and the surface to be cooled. Mr. P. Grootenhuis and Mr. N. P. W. Moore described how this can be done by leading a small quantity of liquid continuously to the surface through fine pores provided in the component. This is known as 'sweat cooling'. It can be readily applied to lightly stressed components, but not so easily to severely stressed components. It is possible that in view of the need for conserving scarce metals, and the improbability of a large and swift improvement of the available alloys, the correct policy for the next few years will be to stabilize the main types of creep-resisting alloy and concentrate upon the efficient use of cooling.

The second problem of the gas turbine is to increase the useful life of the engine from the thousand or so hours demanded of the aircraft engine to the ten thousand or hundred thousand hours required for most industrial applications, while at the same time adopting a cheap fuel, such as heavy fuel oil or pulverized coal. The need for more data on the behaviour of the new alloys over extended periods of time was repeatedly stressed. The difficulty of providing this information while the alloys themselves are being modified continuously has already been mentioned, and furnishes an additional argument for standardizing the alloys as soon as it becomes possible to do so. It was mentioned, however, that the performance of the gas turbine will be seriously diminished if unnecessarily long service lives are insisted upon. The use of cheap fuel introduces the danger of corrosion of the engine by the mineral constituents of the fuel, particularly by the fusible vanadium salts that are present in many fuel oils. Metallurgists could hold out no hope of finding a serviceable alloy that would resist contact with partially molten fuel ash, and looked to the oil technologists to remove, or render harmless, the objectionable constituents of the oil; but the oil technologists could suggest no method cheaper than distillation. It is to be hoped that the last word has not yet been said on this subject. Gas turbines have run successfully for short periods on vanadium-containing fuel oils without serious effects. Much can be done to minimize the danger of corrosion, and it may be that the importance of the problem is exaggerated; but it undoubtedly gives rise to much anxiety.

The immediate future appears to demand the detailed improvement of the existing types of alloy, as a result of which a gradual rise of the strength and reliability of components of all kinds will no doubt take place. The shortage of many essential metals overshadows the situation, and it will be necessary to ensure that the strongest alloys are not used where weaker ones would do, and that no excessive amounts of scarce elements are employed even to meet the most onerous conditions. A prolonged struggle between the more advanced ferritic alloys and the less developed austenitic alloys for use at temperatures between 550° C. and 650° C. is to be expected, with the austenitic alloys gradually yielding place. In view of the complexity of the alloys, all this work will call for a vast amount of metallurgical experiment and mechanical testing. How much improvement is to be expected? The opinion was expressed that the possibilities of the austenitic solid solution alloys based on iron, nickel, chromium and cobalt are approaching exhaustion; and although a somewhat similar opinion was expressed in 1924, it now seems rather unlikely that the temperatures to which these alloys will maintain their strength can be much increased. Improvements of the reliability with which the best properties can be secured are more probable. Some major discovery seems to be required before the service temperatures of gas turbine materials can be greatly increased: it will no doubt be made, but how and where cannot yet be foreseen.

N. P. Allen

OBITUARIES

Prof. V. F. K. Bjerknes, For.Mem.R.S.

Prof. Vilhelm F. K. Bjerknes, foreign member of the Royal Society, honorary member and Symons Medallist of the Royal Meteorological Society, who died at Oslo on April 9, 1951, was the doyen of meteorologists. V. Bjerknes, as he was generally known, was born on March 14, 1862, the son of C. A. Bjerknes, professor of mathematics at Christiania, himself a pioneer in the investigation, theoretical and experimental, of fluid motion. V. Bjerknes, during his education at Christiania, assisted in his father's investigations and afterwards worked in Germany under Hertz. He became specially interested in the (apparent) action at a distance of solids moving in a circulating fluid and the analogies with electrodynamics. After his appointment in 1893 as professor of mechanics and mathematical physics at Stockholm, he prepared his first important work, lectures on "Hydrodynamische Fernkrafte", issued in two volumes during 1900–2. He was later to indicate in a lecture at the Royal Institution in May 1924 the analogy between the forces on a rotating cylinder moving through a fluid and the forces on an aeroplane due to the circulation induced by the asymmetry of the wing. The forces, lifting the cylinder, at quite moderate speeds are substantial and can be exactly controlled by adjusting the speed of rotation.

In 1898 Bjerknes introduced into dynamical meteorology the concept of 'solenoids', the tubes formed by the intersection of a system of isobaric surfaces at unit intervals with a system of isosteric (equal specific volume) surfaces also at unit intervals. He showed that if C is the circulation around any closed circuit, $dC/dt = N$, the number of solenoids intersecting the circuit. He deduced that, for a fluid in equilibrium, N must be zero, and that if N is not zero, the induced circulation is in the direction which will bring the isobaric and isosteric surfaces into coincidence (or parallelism). Bjerknes thought at first that this would have very wide meteorological uses and he applied it to the sea breeze and the Indian monsoon. But he soon realized that the effect of the rotation of the earth, though small in the initial development of motion from rest, became of great importance in the major movements of the atmosphere, and that he must include with N a term $-2\omega \frac{dS}{dt}$, where S is the area of the projection of the circuit on the equatorial plane and ω is the angular velocity of rotation He did this in 1901, and pointed out the fundamental deduction that a circuit acquires cyclonic or anticyclonic circulation according as it contracts or expands

From this time, for the next twenty years, Bjerknes devoted his energies to the problem of approximate integration of the equations of motion of the atmosphere (and the ocean) as a necessary preliminary to a practical scientific method of forecasting weather In this he had the assistance first of J W Sandstrom and then of many other collaborators, notably Th. Hesselberg, and from 1906 he received financial assistance for his investigations from the Carnegie Institution of Washington There resulted "Dynamical Meteorology and Hydrography", a treatise designed to present in an ordered and rational form the principles and the practical aids to the development of meteorology and hydrography from the point of view of a mathematical physicist The treatise was planned in three volumes , but only two were completed and issued, in 1910 and 1912 It emphasized the importance of a universal co-ordinated system of units and included the proposal, first put forward in 1906, to use absolute units of pressure, and introduced the terms 'bar' (megadyne per cm ^{2}) and 'millibar' as the practical units for hydrography and meteorology respectively The millibar has now become established throughout the world in meteorology and aviation, though not yet in physical laboratories, still wedded to the mercury inch and mercury millimetre The treatise included also the first explicit statement of the important result that the distance between contour lines on an isobaric surface in the atmosphere is an inverse measure of the geostrophic wind, independent of the density of the air This has been the main factor in influencing meteorological services to use contours on isobaric surfaces instead of isobars on geopotential surfaces in the practical application of upper air observations

Bjerknes had left Stockholm for Christiania in 1907, and five years later he went to direct the new Geophysical Institute at Leipzig He gathered around him a band of workers and initiated two series of publications , one of actual synoptic situations and the other of special researches, notably those by Hesselberg and Sverdrup, and, in later years, of Bergeron and Swoboda The First World War took away his ten German assistants—half of them were killed—and in 1917 he left Leipzig for Bergen He had already, in a lecture in London in 1910, emphasized the value of charts of stream lines in revealing lines of convergence Their further application, begun at Leipzig and continued at Bergen, led to the development of frontal and air-mass meteorology, including the polar front and the structure of cyclones These have played an outstanding part in meteorology in the past thirty years Bjerknes freely acknowledged the contribution of Bergeron, Solberg, and his son, J Bjerknes, to this development, but he was himself the architect of the building and the inspirer of the workmen In 1920 he and Helland Hansen arranged a meeting in Bergen with British meteorologists, including Sir Napier Shaw and Dr L F Richardson, and the discussions were renewed in 1921 at a meeting of the International Upper Air Commission, of which Bjerknes was president The enthusiasm of the 'Bergen' School was infectious and inspiring

In 1926 Bjerknes left Bergen, where the work was continued by his pupils and whither meteorologists from all over the world were drawn He returned to his former chair at Christiania (now Oslo), and with the collaboration of Solberg, J Bjerknes, Bergeron and Godske completed and published the three-volume treatise on "Hydrodynamics and the Applications to Meteorology", issued in 1933–34, which stands as his permanent memorial He retired in 1932, but continued to take an active part in international meteorology He presided over the fruitful meetings of the Association of Meteorology of the International Union of Geodesy and Geophysics at Edinburgh in 1936 He lived in Oslo during the German occupation, sad but courageous In 1946 he paid his last visit to England, when he and Prof C Størmer were the two delegates from Norway to the Newton Tercentenary Celebrations of the Royal Society In the summer of 1948 he was looking forward cheerfully to his winter ski-ing

Bjerknes was dignified in manner, in appearance and in his presentation of his scientific work , but with his dignity he combined a certain modesty and an unfailing attraction and stimulus to younger men Through them his influence on meteorological development has been outstanding in the meteorological services of all nations

Bjerknes married, in 1893, S H Bonnevie, whose gracious and warm-hearted hospitality at the Bergen meetings of 1920 and 1921 was a fitting, well-remembered counterpart to the scientific enthusiasm of Bjerknes and their son, Prof J Bjerknes, to whom meteorologists throughout the world will wish to tender their respectful sympathy in his loss.

E Gold

Mr. H. St. J. K. Donisthorpe

Horace St John Kelly Donisthorpe, who died on April 22, was the sole survivor of the 'great five of myrmecology In the period between 1850 and 1950 immense advances were made in the study of ants These embraced practically every field the re-organization of their taxonomy, the study of their distribution, their life-history, polymorphism, and behaviour Thousands of papers were produced and more than ten thousand new species were described during this period The inspiration behind all this work was the existence of five great students of ants, Auguste Forel in Switzerland, Wasman in Holland, Wheeler in America, Emery in Germany, and Donisthorpe in Britain Each one was an amateur

Donisthorpe published his first paper on ants in 1908 Since then he has published more than three hundred papers reporting his studies on ants His book. "British Ants", first published at his own expense in 1915 and re-published considerably enlarged and amended in 1927, is still the book to which anyone seeking knowledge about the ants of Britain must turn

To-day, Donisthorpe is remembered chiefly as a taxonomist He always sought to encourage people to study ants, and he would go to any lengths to help them to make their studies more accurate and worth while In his early days, he spent much time studying the behaviour of ants, especially their slave-making and the way in which the queen ants (females) found new colonies

At the same time, most of Donisthorpe's knowledge of ant behaviour was learnt in the field in the manner of the old school it was learnt by his wanting to know more about their habits because he wished to collect more specimens or obtain the queens

Personally, Donisthorpe was a great character The last time I saw him he recounted again with pride how in his twenties he had swum across the Rhine near Heidelberg, a feat which, so it was said, no one had achieved before Lately, he persevered in his attempts to continue going to the British Museum (Natural History) each day, or at least for some days each week, until his death

Derek Wragge Morley

NEWS and VIEWS

Mathematics at Birmingham : Prof. G. N Watson, F.R.S

The chair of mathematics in the University of Birmingham will be vacated at the end of the present session by Prof George Neville Watson, who has held it since 1918 Prof Watson, who was born in 1886 and educated at St Paul's School and Trinity College, Cambridge, was senior wrangler in 1907 and became a Fellow of Trinity in 1910 He was elected to the Royal Society in 1919 and became successively president of the Mathematical Association in 1932 and of the London Mathematical Society in 1933 He is a Gold Medallist of the Danish Royal Academy of Sciences, and among other distinctions is an honorary LL D of the University of Edinburgh Prof Watson's name first became known by several important memoirs on asymptotic series, which were followed by a series of papers in which he found asymptotic expressions and approximations for all sorts of functions by the method of steepest descents (a term coined by him and which is now standard) About 1917 many of the ablest mathematicians were attempting to sum a difficult series which had presented itself in connexion with the diffraction of wireless waves around the earth Prof Watson solved the problem, and went on to study the transmission of electric waves when it is assumed that the earth is surrounded by a concentric conducting layer Other celebrated researches were concerned with general transforms and the Rogers–Ramanujan identities Prof Watson is well known to all honours students of mathematics by two books, "Modern Analysis" (written in conjunction with Sir Edmund Whittaker) and the "Theory of Bessel Functions", perhaps the most important single work that has ever been written on the analysis of functions

Dr. R. A. Rankin

Prof Watson is to be succeeded by Dr Robert A Rankin, at present lecturer in mathematics in the University of Cambridge From Fettes College Dr Rankin went up in 1934 to Cambridge, where he is now a Fellow of Clare College , he was a wrangler in 1936, and took a distinction in Part 3 of the Mathematical Tripos the following year He started on a research career in the field of the theory of numbers, and five papers appeared before the end of 1940 Shortly after the outbreak of the Second World War, groups of research students were recruited to defence departments to expand their limited effort, and Dr Rankin was among the first team to join the relatively new Projectile Development Establishment of the Ministry of Supply, formed to develop rockets The theory of numbers was scarcely applicable, but his quality as a mathematician was soon obvious, first in day-to-day development problems of rocket weapons, and later in a more fundamental way He became a leading member of Prof L Rosenhead's ballistics branch and was to put on a firm foundation the mathematics of rocket theory, particularly that of spinning rockets This work has been published (*Phil Trans Roy Soc* , A, 241, 457 , 1949) and places on record a paper comparable to that of Fowler, Gallup, Lock and Richmond on the spinning shell, which was the fruit of research of the First World War Since then Dr Rankin has returned to the theory of numbers, and has already to his credit a long list of research papers on the differences between consecutive prime numbers and the properties of the coefficients of modular forms More recently he has turned his attention to problems in linear forms and has discussed such problems as the packing of convex bodies and associated problems in the geometry of numbers

United States Office of Naval Research

Dr Emanuel R Piore has recently been appointed deputy and chief scientist of the United States Office of Naval Research, in succession to Dr Alan T Waterman, now director of the National Science Foundation Dr Piore graduated in physics from the University of Wisconsin in 1930 and took his Ph D there in 1936 During 1938–42 he was engineer in charge of the television laboratories of the Columbia Broadcasting System, interesting himself in the development of colour television After service during the Second World War as a senior physicist in the Navy's Bureau of Ships and then in the Navy Reserve as a lieutenant-commander, he joined the Office of Research and Inventions (later to become the Office of Naval Research) in 1946 as head of the electronics branch, and since 1949 he has been deputy for natural sciences Dr Piore's previous post at the Office of Naval Research has been filled by Dr Randal N Robertson, formerly director of the Physical Sciences Division of the Office Dr Robertson will be responsible for research in the earth, physical and mathematical sciences He went to the Office of Naval Research in 1946 from the Radiation Laboratory of the Massachusetts Institute of Technology, where he had been engaged in war-time research and development of airborne radar bombing systems

"Science News"

Several recent articles have commented on the outstanding advances in science and particularly in physics made during the past fifty years and on the profound effect these advances have had on our everyday life The importance, both to industry and to science, of informing, without undue delay, as wide a public as possible of the investigations being undertaken by men of science, of the results obtained and of their implications has been correctly emphasized Whereas the scientific periodicals of the various professional bodies have for long catered for the specialists and research workers, it is only comparatively recently that a scientific Press serving the non-specialist has appeared For the general public, most newspapers now have on their staffs journalists, some of considerable merit, who regularly report on the progress of science It is to be expected that, though their reporting is usually accurate, it is often highly coloured and somewhat exaggerated to cater for popular taste. However, between the two extremes of the specialist and the general newspaper reader, there is a large public consisting of educated laymen with wide interests who require something which is more detailed than the newspapers can give but which, while presented in a serious, authoritative, concise and interesting manner, should yet avoid the terminology and preciseness of the specialist article

In June 1946 the first number of "Science News" appeared, and it was at once acclaimed as a welcome and important addition to the then available scientific literature It satisfied the particular and peculiar need of the specialist interested in what is going on in branches of science other than his own, and of the educated layman The fact that No 1 has since been followed at brief intervals within the past five years by no less than eighteen further issues in the series is sufficient indication of their considerable popularity and undoubted success The publishers are to be congratulated on their enterprise, and the editor, Dr J L Crammer, for devoting his spare time and considerable energy to the promotion of such a worthy object and with such remarkable success No 19 in the series of "Science News" (Harmondsworth Penguin Books, Ltd, 1951, 1*s* 6*d*) records that a new editor has been appointed, namely, A W Haslett, who, as a frequent contributor to "Science News", the editor of the weekly *Science To-day*, science broadcaster and author, is well known as a science journalist His wide knowledge, his many contacts in the universities and research laboratories and his deep appreciation of scientific truth are particularly mentioned in the editorial of No 19 as qualities which will ensure that under his guidance "Science News" will maintain its already high standard

Lord Rutherford. An Appreciation

THE text of the Fifth Rutherford Lecture of the Physical Society, delivered before the Society by Dr A S Russell, of Christ Church, Oxford, on December 8, 1950, has recently been published (*Proc Phys. Soc*, A, 64, 217, March 1951) Describing himself as an inorganic chemist and a former pupil and admirer of Lord Rutherford, Dr Russell not only gives his impressions of Rutherford as a man and physicist, but attempts also to explain why it was that the inorganic chemists were so slow, in the years preceding 1914, in arriving at the conceptions of isotopes and atomic number The years 1907–19 which Lord Rutherford spent at the University of Manchester are described as "the great middle period of Rutherford's life of discovery" Many famous physicists, including Chadwick, Darwin, Marsden, Nuttall, Robinson and the brilliant Moseley, were members of his staff He had the co-operation for a time of Niels Bohr, and many notable men of science from other universities came for long or short periods to work with him at Manchester

Dr Russell refers only briefly to Rutherford's scientific achievements, for they have been described in detail elsewhere It is, however, by well-chosen illustrations and anecdotes that Dr Russell brings out clearly the remarkable qualities of the great man Rutherford's foresight and penetration, in addition to good fortune, his insight into scientific problems, his great experimental skill, his exuberance when off duty and his seriousness at work, and, over all, his kindness and generous outlook on life Finally, Dr Russell considers the general question of the paramount importance of the 'great man' in science It is his belief that we cannot afford in science not to know anything that possibly can be discovered, and that in the pursuit of knowledge we cannot afford to do without the 'great man' The team of talented workers may finally make some great contribution to science, but the more fundamental the science, Dr Russell asserts, the greater is the need for the big advances which only great men can make Rutherford "by probing the atom to its very depth not only revealed great truth and great beauty, he showed us by example what one man can do when he makes the most of his great gifts"

Centaurus a New Quarterly on the History of Science and Medicine

AN indication of the steadily growing interest in the history of science and medicine is given by the appearance, in Denmark, of a new quarterly journal, *Centaurus*, an addition to the not very extended ranks of the periodical literature on these subjects The journal is published by Ejnar Munksgaard, of Norregade 6, Copenhagen, and the general editor is Jean Anker, director of the Scientific and Medical Department of Copenhagen University Library, who is assisted by a board that includes a number of associate editors drawn from various European countries, North America and elsewhere The first two numbers contain thirteen original articles, rather more than half of which are of medical interest. Additional matter is included under the headings varia, book reviews, list of books received, and obituaries The quarterly is well printed on good paper and adequately illustrated The editorial board appears to have set a high standard for this new publication, and it should receive a welcome in Great Britain Of particular interest to British readers, whose linguistic attainments are generally more limited than those of Continental readers, is the fact that it is laid down that all articles must be written in one of three languages English, French or German In fact, five of the thirteen articles in Nos 1 and 2 are written in English The annual subscription, about 44*s* post paid, at the current rate of exchange, seems reasonable for these times

Human and Natural Laws in China and the West

IN his Hobhouse Memorial Trust Lecture, delivered on May 23, 1950, at Bedford College, London, and now published (Hobhouse Lecture No 20, pp 44, London Oxford University Press, 1951, 2*s* 6*d* net), Dr Joseph Needham traces the development of the ideas of human law and the laws of Nature in Europe and then reviews Chinese thought on this subject, with the object of discovering whether there is anything which could properly be classed among the factors in Chinese civilization which inhibited the indigenous rise of modern science and technology He concludes that the great distaste of the Chinese for precisely formulated, abstract, codified law, the relatively greater importance of the element of natural law in Chinese than in European society, and the early depersonalization of available ideas of a supreme being and their lack of ideas of creativity, all prevented the development of the conception of the laws of Nature from Chinese conceptions of law in general Moreover, the concrete forces of Chinese social and economic life were not sufficiently favourable to science to overcome such inhibiting factors

Traditional Colonial Art Exhibition at the Imperial Institute, London

An exhibition of traditional Colonial art has been arranged in the Art Gallery of the Imperial Institute, South Kensington, London, S W 7, and will be open to the public until September 30 (weekdays, 10 a m -6 p m , Sundays, 2 30 p m -6 p m) The exhibition presents only work from Colonial territories of the British Commonwealth which is authentically traditional, thus excluding articles made for export or for sale to the tourist and such modern work as is produced under external influence, the selection of the work displayed has been governed by æsthetic considerations, and the exhibition is not planned as an ethnographical or anthropological study The exhibition is divided into two sections, the larger being devoted to sculpture, and the smaller to such crafts as pottery, basketwork, textiles and other forms of cloth, metalwork, etc

Commonwealth Fund Fellowships

COMMONWEALTH Fund fellowships, tenable by British graduates in American universities for one year beginning in September, have been awarded to the following, among others A C Allen, Queen's University, Belfast, and Peterhouse, Cambridge (mathematics), H Davies, Jesus and Merton Colleges, Oxford (theoretical physics), M W Dick, Balliol College, Oxford (symbolic logic), M J Farrell, New College, Oxford, and King's College, Cambridge (economics), R P Jepson, University of Manchester (experimental surgery), M S Longuet-Higgins, Trinity College, Cambridge (oceanography), W S Owen, University of Liverpool (metallurgy), K V. Roberts, King's College, Cambridge (theoretical physics), O Smithies, Balliol College, Oxford (physical chemistry), B A D Stocker, University of London (bacteriology), L E Weiss, University of Birmingham (geology) Dominion and Colonial Civil Service Fellowships of the Commonwealth Fund, tenable by Civil servants from the British Commonwealth, have been awarded to the following, among others, for study in the United States (not necessarily at a university) E W de Lisle, New Zealand (radio engineering), W J Gibbs, Australia (meteorology), K G E Moody, Australia (civil engineering), C H de C Murray, South Africa (psychology), S F Barnett, East Africa (veterinary science), S Woolmer, Singapore (town planning)

University of London

PROF P B MEDAWAR, Mason professor of zoology in the University of Birmingham, has been appointed to the Jodrell chair of zoology and comparative anatomy tenable at University College, London, as from October 1, in succession to Prof D M S Watson The title of reader in anthropology in the University has been conferred on Dr Phyllis Kaberry, in respect of the post held by her at University College The following doctorates have been conferred *D Sc* . Mr L B Holt (University College), Mr R A M Mackay (Imperial College of Science and Technology), *D Sc (Eng)* Mr Guthlac Wilson (Queen Mary College).

Society for Endocrinology Officers

OFFICERS and the committee of the Society for Endocrinology have been elected as follows *Chairman*, Dr S J Folley, *Honorary Secretaries*, Prof C H Gray and Prof. N F Maclagan, *Honorary Treasurer*, Dr F L Warren, *Honorary Editor of the Society's Proceedings*, Dr P L Krohn, *Ordinary Members of Committee*, Prof E C Amoroso, Dr G W Harris, Dr C J O R Morris and Dr E F Scowen Communications should be sent to the Honorary Secretary of the Society, Department of Chemical Pathology, King's College Hospital, Denmark Hill, London, S E 5

Society for General Microbiology

OFFICERS for 1951–52 of the Society for General Microbiology have been elected as follows *President*, Prof J W McLeod, *Meetings Secretary*, Dr W E van Heyningen, *General Secretary*, Dr. J. G Davis, *Treasurer*, Dr R Lovell, *Editors*, Prof B C J G Knight and Mr A F B Standfast The Society, which was founded in 1945, now has 985 members and will hold its September meeting in Manchester Further information about the Society can be obtained from Dr. J. G Davies, 35 Villiers Road, Southall, Middlesex

"Biology in 'Chambers's Encyclopædia'"

IN a review under this title published in *Nature* of April 21, reference was made to the point that, going through the sections letter by letter, certain topics were not found at the points expected. Mrs M D Law, managing editor of the "Encyclopædia" states that, in fact, there is a section on biochemistry, by Prof E H F Baldwin, under 'B', and a paragraph on Canada balsam under 'C', both were unfortunately overlooked by the reviewer As regards the other comments on omissions under appropriate letters, Mrs Law points out each one is dealt with at some point in the work, and can readily be found by reference to the general subject index in vol 15, which is designed to guide readers to the heading including the topic under discussion

A Giant Sunspot

THE big sunspot reported in *Nature* of April 28 (p 672) returned with renewed development to cross the sun's disk during May 9–22 When fully in view near the sun's east limb, the area of this complex group corrected for foreshortening was about 2,250 millionths of the sun's hemisphere, and by the time it had passed the sun's central meridian on May 16 0 U T the area had increased to 4,850 units, or about 110 times the cross-section area of the earth A peak area of this value has been exceeded by only two other spot groups, and equalled by a third, in the photographic record of sunspots maintained by the Royal Greenwich Observatory since 1874 All these spots have occurred in the present 11-year sunspot cycle and appeared successively in February 1946, July 1946 and April 1947, the last attaining the remarkable area of more than 6,000 millionths The first two groups were associated with intense solar flares followed by 'great' geomagnetic storms, in the first case 17½ hours, and, in the second, 26½ hours after the flares The present spot showed little tendency to produce flares up to the time of central meridian passage. On May 18, however, a major flare occurred from 10h 18m until about 13½h U.T., and this was associated with a marked radio fade-out on long distance radio communication.

The Night Sky in June

NEW moon occurs on June 4d 16h 40m U.T., and full moon on June 19d 12h 36m. The following conjunctions with the moon take place: June 2d 21h, Mercury 7° S.; June 8d 18h, Venus 1° S.; June 13d 07h, Saturn 4° N.; June 27d 01h, Jupiter 4° S. Mercury is a morning star during most of the month but is too close to the sun for favourable observation; on June 25 the planet is in superior conjunction and afterwards becomes an evening star, but sets too soon after the sun—forty minutes on June 30—to be observed. Venus, an evening star, sets at 23h 20m., 23h 05m. and 22h 30m. on June 1, 15 and 30, respectively, and is a conspicuous object in the western sky. The planet reaches its greatest elongation east on June 25, and the visible portion of the illuminated disk varies between 0.62 and 0.45 during the month. Mars is too close to the sun to be observed. Jupiter is a morning star, rising at 1h 45m., 0h 55m. and 0h on June 1, 15 and 30, respectively. Saturn, an evening star, sets at 1h 30m., 0h 35m. and 23h 35m. at the beginning, middle and end of the month, respectively, and can be seen for a few hours during the night between β and η Virginis. Occultations of stars brighter than magnitude 6 are as follows: June 23d 02h 43.7m., γ Capr (*D*); June 25d 01h 11.3m., 96 Aqar (*R*). *D* and *R* refer to disappearance and reappearance, respectively, and observations from Greenwich are assumed. Summer solstice occurs on June 22d 05h.

Announcements

H.R.H. THE DUKE OF GLOUCESTER will open the new laboratories of the Tin Research Institute at Fraser Road, Greenford, Middlesex, on May 31.

THROUGH the generosity of Mrs. Armstrong, widow of the late Dr. E. F. Armstrong (president of the Royal Society of Arts and chairman of the Council during 1943–45), and of his son Mr. Richard Armstrong, an endowment has been made for the provision of biennial memorial lectures, to be delivered to the Society on the subject of food. It is hoped that it will be possible to arrange for the first Armstrong memorial lecture to be delivered in the next session of meetings.

A COLLOQUIUM on the "Chemotherapy of Tuberculosis", organized by the Medical Research Council of Ireland, will be held in Trinity College, Dublin, during July 10–13. Further details can be obtained from the honorary secretary of the colloquium, J. G. Belton, at the Laboratories of the Medical Research Council, Trinity College, Dublin.

A SPECIAL discussion meeting of the Royal Anthropological Institute will be held on May 30 to consider "Physical Aspects of Race". The speakers will include Prof. J. B. S. Haldane, Dr. A. E. Mourant, Dr. J. C. Trevor and Prof. S. Zuckerman, who have recently been appointed members of an expert panel of the United Nations Educational, Scientific and Cultural Organization which is to meet in Paris during June 4–8 to consider this subject.

AN ophthalmic optical trade exhibition, organized by the Association of Wholesale and Manufacturing Opticians (secretary: B. G. Arthur, 69 Cannon Street, London, E.C.4), will be held in the two large halls of the Royal Horticultural Society at Vincent Square, London, S.W.1, during July 16–20. About a hundred firms will be exhibiting their products. Prior to the exhibition, during July 10–13, the British Optical Association is sponsoring an international ophthalmic optical congress at King's College, London.

THE fourth annual conference on the "Education of the Young Worker", organized by the Department of Education, University of Oxford, will be held at Manchester College, Oxford, during July 7–13. The aim of the conference is to bring together representatives of industry, education and administration to consider the facilities that already exist for the training of young people, what better use might be made of them, and what should be the ideal programme for the future. The programme can be obtained from the Director, University Department of Education, 15 Norham Gardens, Oxford.

A SERIES of Festival symposia, organized jointly by the Royal Society of Medicine and the British Medical Association, will be held during June at 1 Wimpole Street, London, W.1. The symposia will be open to all members of the medical profession, British and foreign. Some of the topics to be discussed are as follows: the peripheral nervous system (June 4, 2.15 p.m.), antibiotics (June 7, 2.15 p.m.), ophthalmology (June 11, 2.30 p.m.), the central nervous system (June 14, 2 p.m.), experimental endocrinology (June 20, 2.15 p.m.), nutrition and B vitamins (June 21, 10 a.m.), cortisone and A.C.T.H. (June 25, 10 a.m.), physiology of the vascular system (June 25, 4 p.m.), tropical medicine (June 26, 4.30 p.m.), epidemiology (June 27, 4.30 p.m.). Tickets can be obtained from the joint secretary of symposia at B.M.A. House, Tavistock Square, London, W.C.1, and application forms from the May 4 issue of the *British Medical Journal* should be used, if possible.

THE Historical Association will be holding its seventh vacation school for revision courses in history in Thwaite Hall (University College of Hull), Cottingham, East Yorks, during August 2–13. The school is for graduate history teachers and others who are interested, and each member will choose to study within one of seven seminars, there being a tutor and about twelve students in each seminar. One of the seminars is on the "History of Science in the Seventeenth and Eighteenth Centuries", with A. R. Hall, assistant lecturer in the history of science in the University of Cambridge, as tutor. The fee for the course, exclusive of accommodation, is £5 (£4 10*s.* to members of the Association). Registration forms, to be completed by May 31, and further details can be obtained from the director of the school, F. W. Brooks, 14 Wellesley Avenue, Hull.

ASLIB is preparing a central index of translations, which will include scientific papers, reports and published articles appearing in foreign journals, and which when complete is intended to provide a guide to all translations held in Great Britain and the Commonwealth. A limited number of translations has already been indexed, and inquiries concerning them are dealt with free of charge. To ensure that the index will be complete the co-operation of persons and organizations holding translations is requested. All communications should be addressed to Aslib, 4 Palace Gate, London, W.8.

GEL-LIKE BEHAVIOUR OF DEOXYRIBONUCLEIC ACID SOLUTIONS

By Dr. J. A. V. BUTLER and D. W. F. JAMES
Chester Beatty Research Institute, London, S.W.3

IN the course of experiments on the molecular weight of deoxyribonucleic acid, we have noticed that in aqueous solutions it diffuses in a very unusual manner. Instead of the boundary between the solution and the solvent becoming more and more diffuse, while remaining in the same position, as is the case with more normal substances, it was found that the whole boundary moved forward into the solvent, its front edge remaining very sharp for a considerable time. This behaviour is most marked in aqueous solutions without added salts; but it persists to some extent even with moderate salt concentrations. Fig. 1 shows *Schlieren* pictures of boundaries during diffusion under the conditions stated. The interpretation of these pictures, as in the case shown in Fig. 2, is of a sharp front edge moving into the solvent, with a gradual rise of concentration extending into the solution behind it for a distance which increases with time, until the full concentration of the solution is attained. As the diffusion proceeds, the height of the front edge diminishes.

The distance moved by the edge is proportional to $\sqrt{t}$, as can be seen from a typical example given in Fig. 3. This relation is similar to that recently given for the two-dimensional swelling of gels by C. Robinson[1]. The rate of swelling, as given by the slope of this line, varies linearly with the concentration of nucleic acid. The rate of movement of the boundary diminishes rapidly with increasing salt concentration and in 0·2 N salt solutions is scarcely perceptible. But the *Schlieren* diagram remains asymmetric during the diffusion, the edge of the solvent side being much sharper than the other. If the asymmetry of the boundary were due to increase of the diffusion coefficient with decreasing concentration (which is the relation actually observed), it would be expected that the boundary would be more diffuse on the solvent than on the solution side; that is, the molecules would move more rapidly as they get away from each other. The reverse of this is the case, even in salt solutions. It appears, then, that the molecules at the front of the boundary are held back, as they will be if they are united to those behind in some sort of network.

It is well known[2] that, in sedimentation and in electrophoresis, nucleic acid solutions give an exceedingly sharp boundary. This has been ascribed to the self-sharpening property of a boundary when the sedimentation-rate (or mobility) increases with decrease of concentration. It is doubtful if this effect is sufficiently great to give boundaries of the sharpness observed; but they are easily explained if the solutions contain a structural network. The existence of a gel network also explains the high structural viscosity of nucleic acid solutions and their streaming birefringence at very low rates of shear.

To sum up, two types of effects have been observed. In the absence of salt or in the presence of small concentrations of salt (0·05 N), a marked 'swelling' of the nucleic acid solution is observed. At greater salt concentrations such 'imbibition' is inappreciable; but the asymmetry of the diffusing boundary remains. It has long been known that the viscosity of nucleic acid solutions is greatly affected by small concentrations of salts. Jordan has suggested[3] that this effect is due to the addition of electrolyte reducing the mutual repulsion of the charged groups of the polymeric ion of nucleic acid, permitting the molecule to coil, thereby giving a more symmetrical structure.

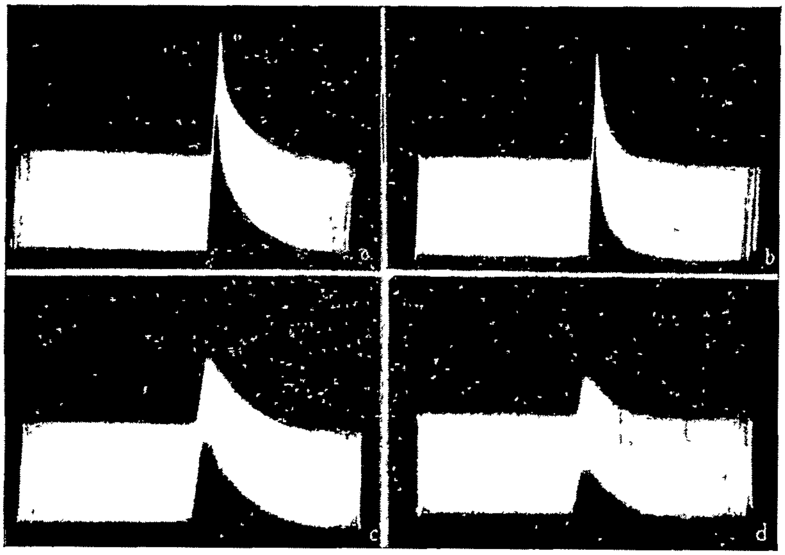

Fig. 1. *Schlieren* photographs of thymonucleic acid boundaries during diffusion
(*a*) 0·4 per cent thymonucleic acid in water after 5·5 hr.; (*b*) 0·2 per cent thymonucleic acid in water after 3 hr.; (*c*) 0·4 per cent thymonucleic acid in 0·001 N sodium chloride after 54·5 hr.; (*d*) 0·2 per cent thymonucleic acid in 0·001 N sodium chloride after 47·7 hr.

If, as we have suggested, the nucleic acid forms a gel network, even in dilute solutions, we should ascribe the 'swelling' in the absence of appreciable salt concentration to the mutual repulsion of the charges, which will cause the gel to expand. When the charged groups are locally neutralized by added ions, the tendency to expand no longer exists; but the gel network will still be present and will give rise to the anomalous boundary which is observed. On this view the drop of viscosity produced by salts would be due to the salt-free nucleic acid being a 'stiff' gel owing to the mutual repulsion of its parts; while, when these charges are neutralized, the gel will be less stiff and its effect on the viscosity will be less. The continued existence of the gel network in salt solutions will explain why the abnormal structural viscosity is still exhibited by them, though at a lower level.

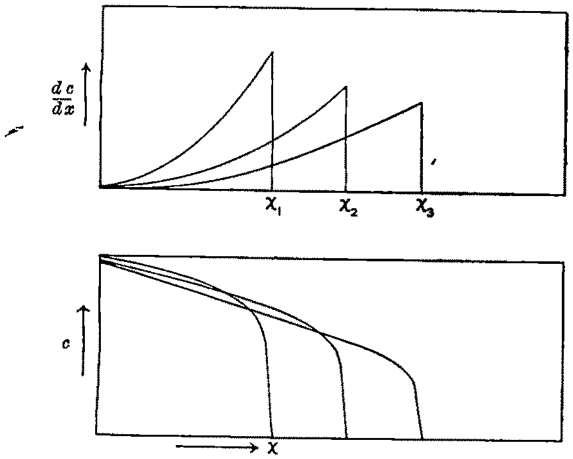

Fig 2 Interpretation of *Schlieren* photographs, showing nature and position of boundary at different times

On account of the anomalous diffusion pattern the values of the diffusion coefficient which have been recorded[4] must be regarded as very uncertain It might be expected, it is true, that the elements of gel network, as well as other types of interaction, will be reduced to insignificant proportions by dilution and that the molecular weights of nucleic acid determined from extrapolation to zero concentration will be free from uncertainty on this account In practice, however, a considerable amount of 'structure' remains in the most dilute solutions with which *Schlieren* pictures can be obtained, and the extrapolations are uncertain The molecular weights so far obtained are thus of uncertain significance

It may be noted that it has been shown[5] that, when nucleic acid is treated with various reactive chemicals such as the nitrogen 'mustard' dichlorethylmethylamine, it loses the structural viscosity and gives rise to comparatively normal *Schlieren* patterns in centrifugation and in diffusion[7] The chief chemical changes produced by this and similar reagents appear to be the alkylation of the groups which are responsible for the formation of hydrogen bonds[6] by means of which the individual chain-like molecules are joined together to form a network It therefore appears to be likely that the molecular weight of nucleic acid treated with these reagents is more representative of the size of the actual unassociated nucleic acid molecule Various values in the region of 10^4–10^5 have been obtained[7] for nucleic acid treated with dichlorethylmethylamine

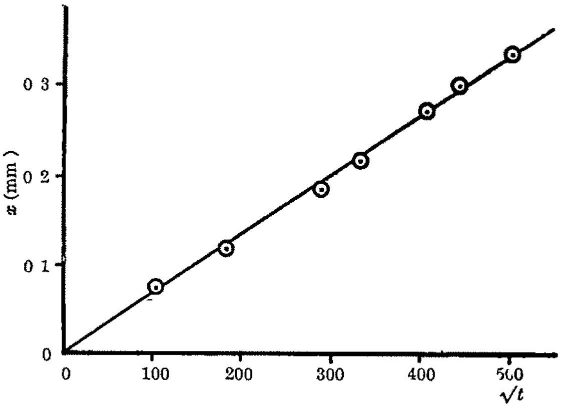

Fig 3 Position of boundary (x) plotted against $\sqrt{t}$ (where t is time in sec)

A fuller account of this work will be published elsewhere

This investigation has been supported by grants made to the Royal Cancer Hospital by the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the Division of Research Grants of the U S Public Health Service [Jan 5

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N-SUBSTITUTED *ISO*GLUCOSAMINE RELEASED FROM MUCOPROTEINS BY THE INFLUENZA VIRUS ENZYME

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INFLUENZA virus is selectively adsorbed to, and afterwards is eluted spontaneously from, erythrocytes and infectible tissue cells[1]; certain mucoproteins by competing for the virus inhibit its adsorption to red cells, a property lost by previous incubation of the inhibitor with active virus[2] From these observations on the biological level, the concept evolved that the action of virus on cells is associated with an enzyme embedded in the surface of the infective particle[3] Because of the wide implications of such a concept, it seemed desirable to provide chemical evidence for the activity of the viral enzyme by isolating and identifying the product(s) of virus-substrate interaction

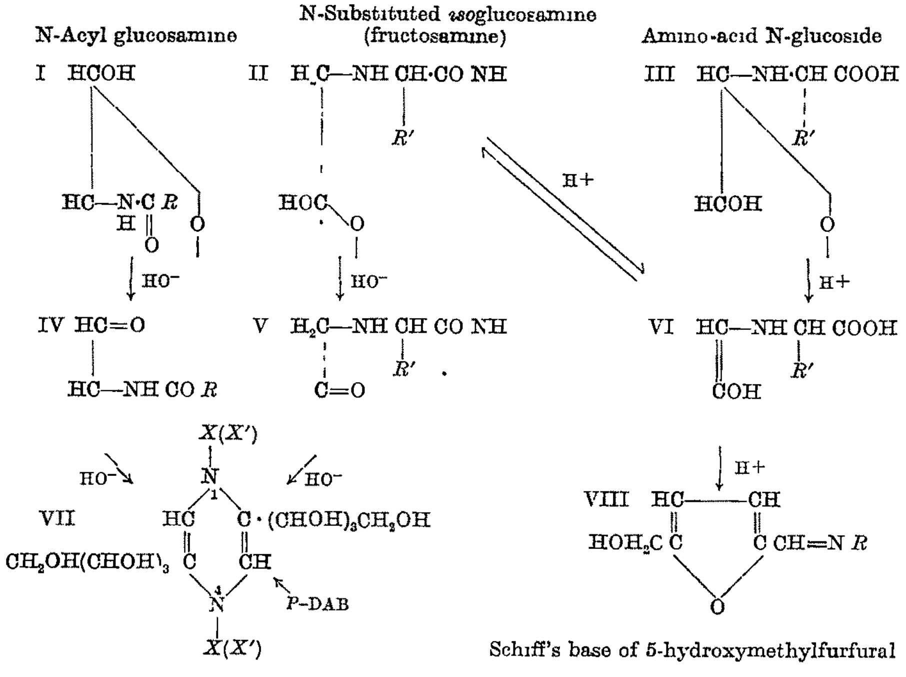
As the first result of an investigation directed towards this end, it was reported that the enzyme of influenza *A* virus liberates from ovomucin a carbohydrate – peptide compound[4]. The nitrogenous compound which had reducing power and gave a positive Molisch test exhibited an unusual feature when treated with alkali (0 1 *N* sodium carbonate, 12 min, 100° C) it became coupled with *p*-dimethylaminobenzaldehyde to give a purple colour identical with, though much more stable than, that produced by N-acetyl D-glucosamine (I), spectroscopic examination disclosed identity of the bands given by the colouring matter with those of N-acetylglucosamine and the compound respectively known as the auxochrome in the Morgan–Elson test[5] However, in contrast to the behaviour of N-acetylglucosamine, the compound was stable to prolonged alkaline treatment (30 min. at 100° C) as tested by colour formation with *p*-dimethylaminobenzaldehyde and by its reducing power, and it was most sensitive to mineral and organic acids. After heating for several hours with 1 *N* hydrochloric acid the reducing power of the compound decreased and it failed to give a colour with *p*-dimethylaminobenzaldehyde, even after appropriate pretreatment with acetylacetone, whereas glucosamine arising from the acid hydrolysis of N-acetylglucosamine is known to withstand 6 N hydrochloric acid without loss of its ability to produce a characteristic red colour with acetylacetone and *p*-dimethylaminobenzaldehyde. Instead, the acid treatment of the compound resulted almost immediately in a dark brown coloration and formation of considerable amounts of black insoluble humin.

Investigation of the properties of the purified ovomucin proved this preparation to be a protein fraction consisting of at least two mucoproteins, the specific substrate for the viral enzyme contributing not more than 5–10 per cent to the total fraction[6,7]. We took advantage, therefore, of a procedure described by Tamm and Horsfall[8] to obtain from human urine a mucoprotein (12·2 per cent nitrogen) acting as inhibitor of virus hæmagglutination. A slight modification of the method provided an electrophoretically homogeneous product[9].

Highly purified influenza *B* virus (*LEE*) containing 100,000 agglutinating doses (against 1 per cent fowl red cells) per mgm. nitrogen[10] was allowed to act on a 0·3 per cent solution of the urine mucoprotein at 37° C. for 3 hr.; the mixture was then dialysed against distilled water and the dialysate concentrated *in vacuo* to dryness; appropriate controls were treated accordingly. By this procedure, followed in part of the experiments by adsorption on to and elution (0·1 N acetic acid) from calcium oxalate, a carbohydrate-containing compound was obtained from the dialysate of the mucoprotein-virus assay in a yield of about 1 per cent of the substrate used.

The compound gave a positive Molisch test and reduced ferricyanide and *o*-dinitrobenzene (in alkali). Its examination by paper chromatography with butanol/acetic acid as solvent revealed a ninhydrin-reacting spot of $R_F = 0·03$, very similar to that given by L-lysine N-glucoside described previously[11] and most probably due to the presence of combined lysine; this spot was not present in the control. After treatment of the compound with 6 N hydrochloric acid at 100° C. for 24 hr., one or possibly two ninhydrin-reacting spots of low R_F value were located, one of them very suggestive of free lysine. The carbohydrate could not be detached unchanged from the amino-acid(s) by acid hydrolysis; again, treatment with dilute acid (0·1 N hydrochloric acid or 0·5 N oxalic acid) at 100° C. turned the compound into dark-coloured soluble and insoluble material, coincident with a decrease in reducing power. Whereas a quantity of the compound containing 0·2 mgm. reducing substance (as glucose) gave a stable, intensely purple colour in the Morgan–Elson test, upon heating with 1 N hydrochloric acid for 5 hr. at 100° C. its ability to produce a colour with *p*-dimethylaminobenzaldehyde with or without acetylacetone was lost. This behaviour and its stability towards alkali (0·1 N sodium carbonate, 100° C., 30 min.) excluded *N*-acyl-hexosamine as a component of the compound.

A similar sensitivity towards mild acid treatment was observed with amino-acid N-glucosides (III) prepared from their components at 37° C., as described previously[11], or in a pure state and better yield by refluxing the aldohexose and amino-acid in dry methanol for 8–10 hr. DL-Phenylalanine N-glucoside when treated with 0·5 N oxalic acid or 0·01 N hydrochloric acid turned black within 3 hr.; the chromatogram showed free phenylalanine, 5-hydroxymethylfurfural, a small amount of unchanged N-glucoside, but no free glucose. In their reaction towards alkali, however, the secondary N-glycosides differed from the compound. When heated at *p*H 9·0 for 12 min. at 100° C., phenylalanine N-mannoside decomposed with liberation of the amino-acid. Furthermore, the pure amino-acid N-glycosides did not form a colour in the Morgan–Elson test; it was only after heating with acetylacetone in alkali that a reddish colour similar to that of a D-glucosamine standard was formed on addition of *p*-dimethylaminobenzaldehyde.

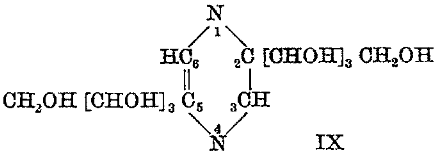


Schiff's base of 5-hydroxymethylfurfural

1,4-Disubstituted dihydropyrazine derivative
(X = —CO R, X' = —CHR' CO NH)

Since the compound split off from mucoprotein closely imitated I in the colour of the Morgan–Elson test, and shared with III the sensitivity towards mild acid treatment, structure II—in its principal features an isomer of both I and III—suggested itself as the configuration of the compound in question. N-Substituted *iso*glucosamines have been prepared from D-glucose and primary aromatic amines such as *p*-toluidine and α-phenetidine with hydrogen ions as catalyst[12]; they are derived from the corresponding N-glucosides by isomerization and are essentially 1-substituted ketoses, as evidenced by the positive colour reactions for ketoses, their ability to form oximes and the failure to detach glucose by acid treatment Our compound was found, too, to give the colour tests for fructose (Seliwanoff, Tashiro and Tietz), and not to release its sugar moiety upon acid treatment

It may be mentioned that *p*-tolyl *iso*-D-glucosamine undergoes humin formation even more readily than does *p*-toluidine N-glucoside Apparently the tautomeric mobility of the vinylamine structure VI formed under acid conditions from both II and III greatly facilitates the formation of the Schiff's base of 5-hydroxymethylfurfural (VIII), an intermediate in the production of the latter and most probably of humin[11] In the acid-resistant glucosamine the amino-group is attached to C_2 and displaces there the hydroxyl essential in the process of sugar dehydration by acid



IX

2,5-Di-tetrahydroxybutylpyrazine

The common feature of the N-substituted amino-sugars glucosamine (I) and fructosamine (II) is the presence in them of the potential α-amino carbonyl grouping (IV, V) which would seem to be a prerequisite for the positive Morgan–Elson test Since α-amino-ketones and aldehydes of the types $R\,CO\,CH_2\,NH_2$ and $CHO\,CHR\,NH_2$ respectively readily self-condense to the dihydropyrazine derivative and in turn are oxidized to the corresponding pyrazine, it may be assumed that glucosamine and fructosamine are transformed by alkali treatment into the same pyrazine derivative, 2,5-di-tetrahydroxybutylpyrazine (IX), indeed, ammonia-treated fructose has been shown[13] to undergo condensation and oxidation to IX Obviously the N-substituted amino-sugars I and II can form only the N-substituted dihydropyrazine derivative VII Structure VII with two active hydrogens to react with *p*-dimethylaminobenzaldehyde would account[14] for the colour formation in the Morgan–Elson test VII with X as substituent (cf diagram) may be expected to give an unstable colour with *p*-dimethylaminobenzaldehyde, since under the impact of the acid present (mixture of glacial acetic and hydrochloric acid at 20° C) the amide bond $>$N—CO R will be slowly split and the resulting compound oxidized to the resonating pyrazine derivative IX, which is devoid of an active hydrogen atom On the other hand, VII with X' as substituent will be stable both to prolonged alkali treatment in the heat and to acid at 20° C , because in this case the link is of the $>$N—CH $R\,R'$ type The weakly positive Morgan–Elson test observed with purified amino-acid N-glycosides after mild acid treatment and with our earlier preparations[11] results from a transient Amadori rearrangement to the corresponding N-substituted *iso*glucosamine , this could be demonstrated by the observation that subsequent to this treatment they acquire the ability to reduce instantaneously *o*-dinitrobenzene in the cold

On the evidence presented, it seems justified to ascribe to the compound liberated enzymatically the *iso*glucosamine structure II, and to define it as N-1-deoxy-1-ketose amino-acid (or peptide) The presence of the sugar is shown by the Molisch test, its keto configuration by the Seliwanoff test and the existence of a free reducing group by the reduction of ferricyanide and *o*-dinitrobenzene The positive Morgan–Elson test is indicative of a substituted amino-group in the α-position to the reducing group (N-substituted amino-sugar), and the stability to acid and alkali of the bond linking the substituent with the amino-group demonstrates that the amino-group is not associated with a carbonyl-group Finally, the ready transformation by mild acid treatment of the compound into humin material may be taken as additional evidence for the attachment of the amino-group to C_1 of the sugar The result of the chromatographic analysis suggests that an amino-acid or peptide is an integral part of the compound

In conclusion, it may be appropriate to consider the bearing of the findings reported above on our knowledge of the mode of linkage between nitrogenous matter and carbohydrate in natural compounds There would appear to be two distinct types (1) in nucleosides the base molecule derived from pyrimidine or purine is in glycosidic linkage with the pentose and therefore detachable by acid hydrolysis, (2) in amino-sugars the base is bound to the carbon atom vicinal in the reducing group , in the N-substituted 1-amino-1-deoxy ketose, described here, the amino-group is shared between the amino-sugar and an amino-acid, thus moulding the carbohydrate and amino-acid into a compact unit from which the sugar moiety cannot be recovered by simple hydrolysis This type of linkage between a carbohydrate and amino-acid may well represent a general pattern according to which, in mucoproteins, the poly- or oligo-saccharide is joined to its protein partner

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TEXTURE AND STRUCTURE OF METALS

THE spring meeting of the X-Ray Analysis Group of the Institute of Physics was held at Ashorne Hill during April 12–13, the papers presented dealing with metals Since a detailed report of the conference is to appear elsewhere, this present article is concerned only with general tendencies as they appeared to one particular member , omission of reference to any contribution should therefore be taken only to mean that this contribution was difficult to classify and not that it was necessarily unimportant For obvious reasons, the author has not found it possible to include a summary of the evening lecture given by Prof N F Mott, as this would require an article to itself

Technical Advances

Perhaps the most outstanding impression produced by the various papers is the number of advances in technique, which now allow the solution of problems which were until recently only on the fringe of possibility , no single obvious step forward can be noted, but by attention to detail and the use of analytical methods, results which were formerly qualitative can now be assessed quantitatively, with a corresponding increase in their significance

As an example, the work of Dr R A Smith, of the University of Birmingham, may be quoted Fourier methods[1,2] have been applied to the analysis of the line shapes given by martensite and iron–nickel alloys, and the results show that the cause of the broadening is mainly the presence of internal stresses On a coarser scale, Dr G B Greenough, of the Royal Aircraft Establishment, described investigations of the residual strains and stresses that are present in plastically deformed material , he emphasized that the X-ray method is unique in that it selects grains of particular orientation, and care should therefore be taken in comparing results with those obtained from macroscopic testing methods

Preferred orientation in cold-worked metals was also discussed at some length Although a mass of information is now available, no general theory of its occurrence is yet accepted, and there is little basis for predicting the deformation texture of any particular alloy Starting from the known behaviour of single crystals under stress, E A Calnan and Dr C J B Clews, of the National Physical Laboratory, showed that the texture of several cubic and hexagonal metals can be accounted for This approach, however, is still essentially empirical and a theory of the deformation of single crystals is still awaited

Dr T L Richards, of I C I (Metals), Birmingham, discussed the behaviour of metals under very heavy deformations, and Mme A R Weill gave an example of the practical importance of these studies , she showed how the junction of oriented and unoriented material could be a place of weakness in metallic bodies

Development of Experimental Methods

Progress has not been solely in the improvement of standard methods , much thought has also been given to the development of new methods, a particularly instructive example being given by Dr R W K. Honeycombe, of the Cavendish Laboratory, Cambridge He showed some impressive photographs of single crystals taken by X-ray microscopy[3,4] with magnifications up to about 100 , the method promises to be very useful for examining deformed metal crystals

At the other end of the scale, experiments are also being carried out at the Cavendish Laboratory to extract as much information as possible from polycrystalline material , Mr P Gay described how beams less than 20 μ in diameter are being used for exploring small groups of crystal grains These methods demand considerable experimental skill, and should soon be adding greatly to our knowledge of metals in the polycrystalline state

The long exposures required for X-ray photographs make the ordinary X-ray method useless for following rapid transformations such as those that occur in steels at elevated temperatures This difficulty can be removed by the use of Geiger counters, and Mr H T Heal and Mr H Mykura described their arrangement , they measured the intensities of separate lines given by austenite and ferrite, and were able to find quantitatively how the proportions of the two changed with time at any particular temperature This method should bring a host of new problems within the province of X-ray diffraction

Another noteworthy point which emerged from the conference was the way in which X-ray methods are finding their place in the general scheme of metallurgical investigation About 1930, metallurgists were wont to accuse X-ray diffractionists of appearing to believe that the new method would displace existing methods This charge can certainly not be made now , in some of the papers the use of X-rays merely as an ancillary to other methods were described, and in many others the importance of the correlation of several methods was emphasized

For example, Mr R J Davis, of Oxford, described a detailed microscopic examination of an α/β brass, his results being supplemented by a microbeam investigation undertaken at Cambridge Mr D V Wilson, of the University of Sheffield, described the examination, by magnetic methods[5], of the effects of cold work on cementite, and Dr W Hume-Rothery, of Oxford, made reference to the use of specific-heat measurements[6]

Perhaps the most intriguing results were provided by Dr J F Brown, of I C I (Billingham), who showed electron diffraction photographs of single crystals of metals There appears to be a wealth of information in such photographs, and they provide a way of examining single crystals which are too small for X-ray examination Exposure times are of the order of seconds, and, in fact, patterns can be observed visually on a fluorescent screen

Structure Determination

Of the examples of structure determination mentioned, by far the most prominent was that of the sigma-phase of the iron–chromium system , this phase, when it appears in stainless steels, has deleterious properties, and 'asigmatic' alloys are greatly to be desired Understanding of the nature of the formation of the phase depends upon knowledge of its structure, and Dr A M. B Douglas, of the Cavendish Laboratory, showed how this had been determined

Powder photographs proved to be too difficult to interpret, and the unit cell was determined only from the data provided by electrolytically extracted single crystals This unit cell appeared to be similar to that found by Tucker[7] for β-uranium, and calculation showed that the structures of the two substances were indeed similar Thus, after several years of investigation, the determination of the atomic arrangement appeared somewhat as an anti-climax

Dr J Thewlis, of the Atomic Energy Research Establishment, Harwell, also discussed the structure of uranium , he emphasized the difficulty of interpretation of powder photographs, and stated that systematic methods, such as that of Ito[8], could be misleading

Another interesting structure is that of Mn_3SiAl_9, reported by Dr K Robinson, of the Cavendish Laboratory , this is similar to Co_2Al_5 [9], except that some of the aluminium sites are vacant Dr Robinson suggested that this phenomenon is due to the higher electron concentration caused by the addition of silicon Comparison of structures in this way may well lead to a greater understanding of the metallic state, along the lines of the now-famous Hume-

Rothery rule The importance of structure determination was stressed by Prof G V Raynor, of the University of Birmingham, who made a plea for more structure results to help the theoretician

That complete structure determination is not always necessary was shown by Dr Hume-Rothery, who discussed the γ-copper-gallium phases, as excess of gallium is added, related structures are formed, and, although the atomic positions have not been determined, it is evident from density measurements that the number of atoms in equivalent unit cells decreases This behaviour, which is exactly similar to that of copper-aluminium alloys, appears to be caused by attempts to maintain a constant value for the number of electrons per unit cell[10], this concept may well prove more fruitful than the number of electrons per atom in accounting for structures with vacant sites; such as Mn_3SiAl_9

Mr H J Goldschmidt, of the B S A Group Research Centre, Sheffield, gave a practical bias to this session of the conference He showed how structural considerations provide a basis for the classification of carbides, and described, with a wealth of detail, how it is possible to predict which carbides will be present in a steel of given composition

Structural Perturbations

Not all structures are perfect, and the diffraction effects given by certain imperfect structures provide fascinating material for study Perhaps the best known of these defects is that which occurs in cobalt[11], and an attempt at a theoretical explanation of the structure was given by Dr J W Christian, of Oxford He described the transformation from cubic to hexagonal cobalt as martensitic in nature—that is, occurring by glides of planes of atoms over each other No purely mechanistic description, however, can be said to 'explain' the faults, energy considerations must be the final arbiter, and Dr Christian made no attempts to deal with these

Dr K H Jack, of the University of Durham, described how, in carbon and nitrogen martensites, precipitation of a new phase, such as cementite, may start as platelets only a few unit cells thick, so that one of the Laue conditions for X-ray reflexion is relaxed He described the effect of this phenomenon on X-ray powder photographs Platelets of this type seem to provide a favoured mode of precipitation, as shown by the classical work of Preston[12] and Guinier[13] on age-hardening aluminium alloys Dr A. Taylor, of the Mond Nickel Co, Birmingham, also discussed the martensite structure, and compared the development of this tetragonal structure to that occurring in the copper-manganese system, here the axial ratio changes abruptly from unity and thus he saw no reason why cubic martensite should not occur at low carbon concentrations

Dr J B Newkirk, of the Cavendish Laboratory, described the diffraction effects given by single crystals of the alloy CoPt, streaks pass through the X-ray reflexions, and these again probably represent the incipient formation of platelets An experimental approach to the study of such phenomena was described by Dr. H. Lipson, of the Manchester College of Technology, he described how diffraction gratings of 1 mm spacing were made with different degrees of short-range order, and how the diffraction patterns in visible light[14] could be compared with X-ray diffraction patterns Although only two-dimensional, the method had been used with some success to account for the diffraction effects from $AuCu_3$[15], and Dr Lipson showed a ciné film which demonstrated the growth of superlattice lines from the background of a diffraction photograph

That such studies are not only of academic interest was shown by Mr T R Pomeroy, of the British Non-Ferrous Metals Research Association He described how the corrosion properties of iron-nickel-copper alloys were found to depend upon the development of a periodic structure before dissociation[16], and explained how this structure had been detected by means of the electron microscope

From all these results, and many others which were mentioned in discussion, it was evident that the subject is developing along very healthy lines, theoretical and practical academic work are proceeding in parallel with technical applications, each being dependent upon and invigorating the others Considerable progress may be expected in the next ten years in our understanding of the metallic state, which at present provides so many persistent but fascinating problems H LIPSON

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UNITED STATES NATIONAL ACADEMY OF SCIENCES

AT the annual general meeting of the United States National Academy of Sciences, held in Washington, D C, during April 23–25, the following officers, new members and foreign associates were elected

Home Secretary A Wetmore, at present secretary of the Smithsonian Institution, for a four-year term, in succession to Dr F E Wright, formerly of the Carnegie Institution of Washington, who has been home secretary of the Academy for the past twenty years

New Members of Council J W Beams, chairman of the School of Physics, University of Virginia, and E. C Stakman, chief of the Division of Plant Pathology and Botany, University of Minnesota

New Members W C Allee, head of the Department of Biology, University of Florida, N E Bradbury, director of Los Alamos Scientific Laboratory, Los Alamos, N M, D Brouwer, director of Yale Observatory, New Haven, R E Clausen, chairman of the Division of Genetics, University of California, E DeGolyer, senior partner of DeGolyer and MacNaughton, Dallas, J T Edsall, associate professor of biological chemistry, Harvard Medical School; R M Fuoss, Sterling professor of chemistry, Yale University, R Gunn, director of the Division of Physical Research, U S Weather Bureau, Washington, D C , H F Harlow, chairman of the Department of Psychology, University of Wisconsin, C O'D. Iselin, senior physical oceanographer, Woods Hole Oceanographic Institution, Woods Hole, Mass , R Kellogg, director of the U S National Museum, Washington, D C , R H Kent, associate director of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland , D W Kerst, professor of physics, University of Illinois , C C G King, director of the Nutrition Foundation, New York, S K Lothrop, curator of Andean archæology, Peabody Museum, Harvard University , T B Nolan, assistant director of the U S Geological Survey, Washington, D C , E M Purcell, professor of physics, Harvard University , A J Riker, professor of plant pathology, University of Wisconsin , H. P. Robertson, professor of mathematical physics, California Institute of Technology (on leave to the Weapons Systems Evaluation Group, Washington, D C), F D Rossini, chairman of the Department of Chemistry, Carnegie Institute of Technology, A B Sabin, professor of research pediatrics, Children's Hospital Research Foundation, Cincinnati , F Schrader, head of the Department of Zoology, Columbia University , F Seitz, research professor of physics, University of Illinois , W Shockley, research physicist at the Bell Telephone Laboratories, Murray Hill, New Jersey , T G Thompson, director of the Oceanographic Laboratories, University of Washington , W S Tillett, head of the Department of Medicine, New York University College of Medicine , G T Whyburn, chairman of the Department of Mathematics, University of Virginia , C. J Wiggers, professor of physiology, Western Reserve University School of Medicine , W G Young, dean of the Division of Physical Science, California Institute of Technology

Foreign Associates . P Eskola, professor of geology and mineralogy, Helsinki University , Sir Godfrey Thomson, professor of education, University of Edinburgh , K von Frisch, director of the Zoological Institute, University of Munich

CENTRAL ROAD RESEARCH INSTITUTE, INDIA

A CONFERENCE of chief engineers of Indian States and Provinces which assembled at Nagpur at the end of 1943 emphasized the need for a Road Research Institute The 'Nagpur Report' recommended the construction and improvement of about 400,000 miles of various types of roads , and an efficient and economical execution of such a developmental programme obviously demanded a Road Research Institute The question was considered by the Council of Scientific and Industrial Research as well as by the Ministry of Transport, and it was decided that the proposed Institute should be part of the chain of national laboratories being planned by the Council Road research was to be the care of the Council, while development was to be undertaken by the Transport Ministry, the Council and the Ministry working in the closest co-operation In 1945 the Council appointed a Road Research Planning and Advisory Committee to work out details for the proposed Institute The Planning Committee saw great advantage in locating the Institute near Delhi, particularly as the main and arterial roads converge on Delhi Many sites near Delhi were examined The 32-acre site finally chosen near Okhla on the Delhi–Muttra Road, though only about seven miles from Delhi, is really part of Uttar Pradesh, and has been presented to the Institute by the Bishop of Delhi and Simla

The governing body of the Council of Scientific and Industrial Research received the Planning Committee's recommendations during 1948 The proposals envisage the setting up of one main field experimental station and a road test-track to carry out experiments on different kinds of road surfaces and to test their behaviour under actual road conditions The Council is to provide funds for the establishment of the Institute and will be in charge of it, while the field experimental station will be financed and controlled by the Ministry of Transport Dr R K N Iyengar had already in the latter half of 1947 been appointed assistant director (planning) Dr Ernst Zipkes, a Swiss road engineer, formerly in charge of the Department of Road Research in the Federal Institute of Technology at Zurich, was appointed director, and the Research Institute has been functioning under him in a temporary laboratory at Okhla The foundation stone of the new Institute was laid on September 6, 1950, by the Minister of Transport, the Hon Mr N Gopalaswamy Ayyangar, who explained the scope and possibilities of the Institute and the importance of the work it is expected to do The Central Institute will, among other things, co-ordinate the work of all local stations, such as those at Madras, Karnal, Lucknow, Patna, Calcutta and Poona

Sir Shanti Swarup Bhatnagar, director of the Council of Scientific and Industrial Research, gave a brief account of the steps leading up to the establishment of the Institute. He defined its functions thus (1) fundamental research on the behaviour of materials used in road construction, and devising of methods of measurement for this purpose , (2) correlation of laboratory test results on standard materials with those under actual investigations, in order to enable reliable estimates to be formed of the behaviour of various road materials in practice , (3) tests on soils and a study of soil mechanics for the evolution of low-cost roads , (4) research connected with the standardization of specifications for roads and road-building plant and machinery , (5) devising of instruments for various tests on roads and bridges, such as measurement of the irregularities of road surfaces, impact factors, automatic recording of traffic, etc , (6) studies on the characteristics of different types of road under different traffic conditions, incidence of accidents, road-safety devices and road statistics , (7) undertaking co-operative research schemes and co-ordination with engineering colleges, other research institutes and industrial concerns doing similar work, and tendering technical advice and assistance when sought , (8) dissemination of results of research and experiments by means of pamphlets, journals and films for the benefit of road engineers

Special emphasis, Sir Shanti said, would be laid on rural roads and their development "from easily and locally available material in such a manner that they can be constructed with the help of local labour at a very low cost"

Dr Zipkes, director of the Institute, summing up the tasks of a Road Research Institute, said "Road research investigates how to construct in a given area the most solid and safest possible road using the natural and most economical means" As a corollary and an amplification he added "Highway construction leads its engineers into Nature—Nature under *all* her aspects For roads are meant to overcome Nature, but at the same time they should be in harmony with Nature Above all, roads must essentially be built with the material the surrounding Nature provides We may add bitumen, tar, cement, but as basic material we have to use the stone, the sand, the earth that lies nearby "

It was no accident, therefore, that the foundation stone itself was not the usual marble slab but a rough quartzite stone dug out of the very site With a feeling of pride, Dr Zipkes said "We dug it out of our own ground, very near this place And we brought it here for our foundation stone ceremony to be a symbol of what we are going to do inside the walls that will rise around this stone Use the materials that Nature provides, and search for ways to construct with them the most solid, safest and most economical roads "

PAINTS AND OTHER SURFACE COATINGS

THE results of much new scientific and technological work relating to paints and other surface coatings and printing inks, including new raw materials and equipment, were displayed at the third Technical Trade Exhibition organized by the London Section of the Oil and Colour Chemists' Association and held at the Borough Polytechnic, London, during March 19–21 The number of exhibitors increased from twenty-six in 1950 to thirty-four this year

The Paint Research Station demonstrated an approach to the prediction of the colour of pigment mixtures, and some applications of radioactive tracers The radioactive isotope in natural potassium has been used for determining this element in potassium chromes , and pigment sedimentation, flotation, and drier absorption are other problems to be investigated by the new techniques The mechanism of polymerization will be studied by introducing radioactive carbon into different parts of the molecules of drying oils

A photoelectric colour meter was shown which has eight colour-filters stopped down so that the same amount of light passes through each , one setting for 100 per cent (with magnesium oxide) then suffices for a series of panels Another exhibit, a prototype of a reflecting microscope, showed the instrument to be of simple design and very easily adjusted A system of mirrors projects the image (free from chromatic aberration) on a grey screen, and there is no eyepiece Modifications under development include the use of downward illumination for examining opaque objects

Attractive items for the laboratory were an unbreakable aluminium vacuum desiccator with plate-glass inspection window and grease-free sealing joint, and a metal tap for ordinary glass vacuum desiccators The only vacuum oven made in Great Britain with single-action door closure was also to be seen A new *Z*-blade mixer that was on show has interchangeable 1-pint and 1-quart pan sections and blades, and a heavy-duty stainless steel mixer in three sizes has a new type of packed gland and can be adapted for working under vacuum

Further research and development work on isomerized rubber has led to new applications in printing inks and a new floor paint for concrete, an emulsion providing a vehicle for alkali-resistant wall primers, and a copolymer with styrene for use in water-resistant and anti-corrosive paints A new finely dispersed polyvinyl acetate emulsion was demonstrated to yield more glossy films than older types and to possess better adhesion after immersion in water Newly developed polyacrylate dispersions were shown in leather finishes A new technique gives alkyd resin dispersions of smaller particle-size than formerly suitable for use in industrial paints

Epichlorhydrin alkyd resin coatings, stoved or air-dried, were seen to resist attack by 70 per cent sulphuric acid and 30 per cent caustic soda, while the remarkable heat resistance of silicone-modified alkyds was exemplified by pigmented finishes stated to have been exposed at 450° C for 500 hr and at 300° C for 1,000 hr , which were without apparent deterioration, except some loss of gloss Alkyd-melamine resins plasticized with coconut oil were shown to possess enhanced colour retention

Epichlorhydrin-diphenylolpropane resins, a recently discovered class having only C—C and ether bonds, contain reactive hydroxyl and epoxy groups , their particularly good resistance to strong alkali was demonstrated They can be used cold-cut with a cross-linking resin (for example, urea or melamine), or esterified with drying-oil fatty acids to give air-drying media

Many quite new derivatives of sebacic acid were exhibited, including diallyl sebacate recommended as a cross-linking agent for drying oils, polypropylene sebacate as a non-migrating plasticizer, sebacamide as a urea resin modifier, and sebacic polyanhydride as an alkyd intermediate A series of chlorine-containing plasticizers for cellulose acetate comprises trichlorethylideneglycerol and derivatives A new 'sequestering' agent, the di-sodium salt of ethylene diamine tetra-acetic acid, can deactivate the ions of various metals, and may be used to prevent 'poisoning', decomposition, etc , caused by traces of metal ions, to stabilize emulsions, to titrate metals, and for many other purposes

Two new adipates, the dinonyl and di(3,5,5-trimethylhexyl) compounds, were shown as low-temperature plasticizers for cellulose derivatives and resins, and two new phthalate plasticizers for lacquers are the di(2-butoxyethyl) and di(ethylene glycol monobutyl ether) compounds New high-boiling solvents for non-blushing nitrocellulose lacquer emulsions are octyl acetate (b p 198° C) and nonyl acetate (b p 207° C)

Calcium plumbate is a new, light-coloured pigment for anti-corrosive paints , a pale dull tan, it can be tinted green, light stone, grey or brown The known anti-corrosive property of zinc dust was related in a demonstration to the electrical conductivity of coatings made with this pigment Interesting panels showed new work with zinc dust in inorganic media such as sodium silicate , in 'cementiferous' compositions based on barium chloride, potassium dihydrogen phosphate and magnesium chloride , and mixed with zinc oxide in a wood primer Research on zinc oxide pigments shows that flow and resistance to 'chalking' increase with particle size, while oil absorption falls , under ultra-violet radiation the more reactive particles can be distinguished from the less reactive by the colour of their fluorescence

NEIL R FISK

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Asymmetry of Larval *Amphioxus*

THE evidence for the theory that *Amphioxus* is "essentially a pædomorphic transformation of a sessile Protascidian" is even stronger to-day than when Garstang[1] first proposed it. The more recent of Conklin's investigations[2] have shown the early development of *Amphioxus* to be "more strikingly like that of Ascidians than has been recognized hitherto", and the fate-map of *Amphioxus* is very closely similar to that of *Ascidiella*[3]. One apparent anomaly—that the egg of *Amphioxus*, unlike the ascidian's, is still of the 'regulation' type after its first cleavage[2]—yields to Berrill's quantitative proof[4] of the relative retardation of the development of *Amphioxus*, and the absence of a larval enterocœle and segmented mesoderm in Ascidians may perhaps do so too. But there remains one notorious obstacle to attempts to bring the two forms more closely into line: the grotesque asymmetry of the *Amphioxus* larva. Half a dozen theories have therefore been devised to explain it away as a larval adaptation of secondary import, but none has been proposed with much conviction or generally agreed upon. The interpretation to be set out here, so far from alienating *Amphioxus* from the ascidian, argues for an even closer affinity between them than is generally admitted.

It is usual to think of the asymmetry of the pre-metamorphic embryo of *Amphioxus* in terms of the positions which the mouth and pharyngeal organs come to acquire in the adult, but for some purposes it is more revealing to think of it in relation to the disposition of the endopharyngeal apparatus in the ascidian tadpole. In the typical fully developed ascidian tadpole, the mouth is dorsal and the pharyngeal axis lies at right angles to the axis of the notochord. The presumptive posterior wall of the pharynx is therefore ventral and the presumptive mid-ventral line, with the endostyle, anterior. It may be said, following Willey closely[5], that the lay-out of the endopharyngeal apparatus of the larva of *Amphioxus* is about as close to that of the ascidian larva as the forward extension of the notochord allows. The mouth cannot be dorsal, but it is lateral or dorso-lateral, the endostyle, though of necessity lying somewhat obliquely, is more nearly vertical than horizontal and is still the most anterior endodermal organ of the body[5]. Garstang[1] would have none of this interpretation, because it rested "on the impossible assumption that the dorsal position of the mouth in ascidian larvæ is primitive", but that, in its turn, rests upon the acceptance of a much more distant affinity between ascidians and *Amphioxus* than modern evidence requires.

What is the phylogenetic history of the complex morphogenetic movement, in consequence of which the presumptive mid-ventral line of *Amphioxus* comes to assume its adult position and the mouth becomes an anterior aperture lying ventral to the axis of the notochord? The suggestion to be made here is that this movement is homologous with the complex rotation of the endopharyngeal apparatus which the ascidian tadpole undergoes in anticipation of sessile life. (An analogous shift in the relative position of the mouth occurs during the metamorphosis of the motile larvæ of other sessile invertebrates, for example, among crinoids, Polyzoa Endoprocta and cirripedes.) The two processes are not easy to compare, for one refers the metamorphic torsion of *Amphioxus* to the axis defined by the notochord, and that of the ascidian to its point of fixation, and the second comparison is obscured by the involution of the larval notochord and nervous system that accompanies metamorphosis. Nevertheless, the outcome of the torsion process in ascidians is to cause the endostyle to take up an anatomically mid-ventral position and the mouth to lie anteriorly and ventrally. The larval torsions of *Amphioxus* and ascidians have, therefore, the same anatomical outcome, though the ways in which it is achieved are a little different, as the persistence and forward extension of the notochord in *Amphioxus* might well require.

The natural or artificially induced delay of tail resorption in some ascidian tadpoles strengthens this interpretation, for it is a 'natural experiment' which answers the question: 'What would be the final disposition of the endopharyngeal apparatus in ascidian larvæ if fixation and metamorphosis were pædomorphically excised?' The larva of *Distaplia* figured by Berrill[6], still free-swimming at a stage when it should normally be sessile, shows the notochordal axis, mouth, endostyle, pharynx and gut arranged in the pattern which they come to acquire in *Amphioxus* after metamorphosis is complete. The behaviour of larval *Amphioxus* is also most revealing. Over the period during which, if it were indeed an ascidian, it should attach itself to the substratum and undergo metamorphosis, *Amphioxus* stops growing in length, deserts the surface waters, and becomes immobile or relatively inactive, it may also, as Orton first showed[7], attach itself to the substratum on its front end. The organs by means of which it does so, if van Wijhe is to be believed[8], are cutaneous sticky-secretion glands homologous with the adhesive papillæ of ascidian tadpoles. (The glands disappear at metamorphosis.) It is very hard to believe that this rather exact correspondence of behaviour is no more than a gratuitous coincidence. If Willey's proposal is accepted—that the larvæ of the organisms ancestral to *Amphioxus* had dorsal mouths and anterior endostyles—then it follows naturally that metamorphosis of *Amphioxus* and the behaviour associated with it is a phylogenetically transformed variant of the metamorphosis of ascidians.

In the light of this interpretation, Garstang's theory of the origin of *Amphioxus* from ascidians needs a small qualification. It is perhaps not quite right to say that *Amphioxus* is a pædomorphic *prot*ascidian. It is a pædomorphic transformation of an ascidian of perhaps great geological antiquity but of relatively up-to-date pattern—one in which the endopharyngeal apparatus belonging ancestrally and functionally to the sessile adult stage appears precociously in the larva. The big sack-like pharynx perforated by gill slits, the mucus-secreting endostyle, the ciliary feeding-current, the atrium, etc., are physiologically appropriate to a *sessile* animal, the adult tunicate. The occurrence of these structures in the larva (in which they are functionless: the larva does not feed) is a secondary acquisition, an anticipation in the embryo of adult structures[9]. It is from a larva of this type that *Amphioxus* must have been derived, by an almost but not quite complete suppression of fixation and the routine of behaviour with it, and the complete elimination of the tunicate adult stage *Amphioxus* thus contrives to combine the endopharyngeal apparatus of the adult ascidian (which it continues to make use of in an almost exactly ascidian-like way[10]) with the notochord, tail, nervous system, etc , of the larva There seems no reason at all why this sort of thing should not have happened more than once—the Larvacea are evidence that it happened twice—or why it should not begin to happen again to-day or to-morrow It may therefore be that the present-day Cephalochordate genera represent a relatively recent offshoot of the ascidian stem This would not in any important way depreciate their significance for the biologist The modern higher chordates probably arose from ascidians much as *Amphioxus* did that is all we are likely to know about the problem, and we are lucky to know so much

P B MEDAWAR

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March 31

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[1] Garstang, W , *Quart J Mic Sci* , **72**, 51 (1928)

[2] Conklin, E G , *J Morph* , **54**, 69 (1932) , *J Exp Zool* , **64**, 303 (1933)

[3] Vandebroek, G (unpublished) See Dalcq, A , "Form and Causality in Early Development", 37 (Cambridge, 1938)

[4] Berrill, N J , "Essays on Growth and Form" (Oxford, 1945)

[5] Willey, A , "*Amphioxus* and the Ancestry of Vertebrates" (London, 1894).

[6] Berrill, N J , *J Morph* , **81**, 262 (1947)

[7] Orton, J H , *J Mar Biol Assoc U K* , **10**, 506 (1914)

[8] van Wijhe, J W , *Proc Section of Sciences, Kon Akad Wet Amsterdam*, **29**, 286 (1926) , **30**, 991 (1927) (van Wijhe was unaware of Orton's work when he reported on the fixation of larval *Amphioxus*)

[9] Mr H K Pusey, who has given me the most valuable criticism in the preparation of the paper, suggests that the dorsal mouth and anterior endostyle may also be 'forward looking' characters in just this sense In Ascidians, as in *Amphioxus*, the mouth rudiment first appears in an antero-ventral position

[10] Orton, J H , *J Mar Biol Assoc U K* , **10**, 19 (1913)

Effect of Moonlight on Insect Activity

It has been known to entomologists for many years that if a bright light is used for attracting insects at night, the catches are considerably higher near the period of new moon than near full moon One of us (C B W) showed[1,2] that in three successive years, between May and October, the catches in a light trap, both of Lepidoptera alone and of all insects together (chiefly Diptera), reached a peak at, or shortly after, new moon, when the geometric mean catches were three to four times as great as those at full moon

In spite of the fact that it is generally believed that other methods of catching are also poor at full moon, in the absence of any real evidence for this there was a distinct probability that the low catches in a light trap might be due to a lowered relative luminosity and hence a lowered attractiveness of the trap at full moon

During the summer of 1950, we carried out continuous trapping of insects at night by means of a 'suction-trap' which draws in the insects by a strong electric fan, and thus is in no way dependent on reaction to light The insects so caught are mostly Diptera , but many other orders are present

An analysis of five complete lunar cycles between July and November 1950 shows that the geometric mean catches in the four weeks, that is, three days on either side of (1) full moon, (2) last quarter, (3) new moon and (4) first quarter, were as follows

204 , 589 , 1,259 and 562

Each of these figures is the mean of thirty-five nights

These results are slightly affected by accidental differences in temperature and wind on the different nights, and when a correction is made for these, the figures become

240 , 490 , 1,175 and 589

Thus the geometric mean catch in the new moon week is nearly five times that in the full moon week As the records include nights with cloud as well as clear nights, the effect of full moon on a clear night must be greater than this

Mr Healy, of the Statistical Department at this Station, informs me that the differences between full and new moon are significant at the 2 per cent level

It appears, therefore, that the moonlight must have a definite effect on nocturnal insects, and that the low catches in a light trap at full moon are not merely due to a physical reduction of the efficiency of the trap.

Further repetition and analysis will be carried out during the present year In the meantime, we would be glad of any other evidence on this problem, particularly long series of night catches of insects by any technique not depending on attraction to light

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[1] *Phil Trans* , *B*, **226** 357 (1936)

[2] *Trans Roy Ent Soc London*, **90**, 272 (1940)

Photographic Prints produced by Red Blood Cells

PREVIOUSLY I have shown[1] that the red blood cells of certain animals, for example, guinea pigs, have a high sensitivity to light in contrast to others, for example, man, so that, with the same conditions of light intensity, 98 per cent of guinea pig erythrocytes and only 12 per cent of human erythrocytes are hæmolysed The light which is responsible for this action is almost exclusively in the visible region

I have since found this light sensitivity so distinct that it is possible to make photographic prints of any kind, such as a portrait with all its details, by this means

The method used is as follows a solution of 2 per cent agar in saline is mixed with a few drops of guinea pig blood, poured on to a glass plate and, after it becomes solid, covered with another glass plate Then the plates are framed with paraffin wax , on top of them any pattern, such as a photographic negative, is fixed The blood plate mounted in this way is immersed in a glass vessel, cooled by running tap water and exposed for 15 min to a strong electric light (1,000 watts), which is collected in a parabolic mirror After 24 hr in darkness, the picture appears, becoming gradually more distinct , time is the only developer required The process is finally arrested by putting the blood plate (after removing the cover-plate) into a solution of 10 per cent formalin in saline for a few hours After rinsing with water, the plate is dried and can be kept for years

In spite of the fact that the picture is produced by light, and its aspect, with the exception that it is not reversed, is very similar to a photograph with silver salts, the action involved is, of course, quite different First it must be emphasized that it is not due to the iron content of the hæmoglobin or to a bleaching process Indeed, the hæmoglobin contributes very little or not at all to the process, so that a plate made of hæmoglobin and agar is completely ineffective What, in fact, causes the phenomenon described is a destruction of the membrane and/or stroma of a varied number of red cells according to the amount of light they are exposed to, and diffusion of the hæmoglobin so liberated over the whole plate

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[1] Meyerstein W , *J Physiol* , **99**, 510 (1941)

Sorption of Solid Insecticides by Dried Mud

In the course of experiments on the persistence of deposits from aqueous suspensions of different particle sizes of volatile insecticides, it has been found that the residual toxicity of particles of any one size is influenced considerably by the type of material to which they are applied

Most striking results have been obtained on mud blocks made from 'murram', a lateritic ironstone, used in the construction of walls of houses in Uganda Crystals of all insecticides used rapidly disappear from the surface of these blocks when they are kept at 78° F (25° C), and even those of DDT, which is usually regarded as a contact insecticide with a long residual life, are no longer visible after only a few days As would be expected, the larger the particle the longer it persists , but for any given size-range the insecticides used can be arranged in order of increasing persistence, thus 'Aldrin', gamma isomer of benzene hexachloride, 'Dieldrin' and DDT

When DDT and 'Dieldrin' crystals are no longer visible on the surface, the mud blocks lose their toxicity to mosquitoes (*Aedes ægypti*, L) exposed to them for long contact periods On the other hand, blocks treated with the gamma isomer of benzene hexachloride or with 'Aldrin' continue to be effective for a considerable time, after the disappearance of the crystals, against mosquitoes resting on the surface

Chemical tests have shown that with 10–20 micron particles of DDT and gamma-benzene hexachloride, almost the whole of the dosage applied can be recovered from the interior of the block At a dosage of 25 mgm of these particles per sq ft , almost all the DDT is sorbed in the top tenth of an inch, suggesting that considerably higher dosages could be applied before the block becomes saturated Dosages of 10–20 micron gamma-benzene hexachloride particles of the order of 200 mgm per sq ft do, in fact, disappear from the surface in 24 hr at 78° F The rate of disappearance from the surface decreases as the relative humidity of the atmosphere increases This may be explained by competition between water vapour and the insecticide vapour for the adsorbing surface An interesting effect observed is that under absolutely dry conditions the sorbed DDT is catalytically decomposed to the ethylene derivative, the soil used having a high iron content This again suggests that the insecticide is present in the block as a highly active surface layer

The gamma isomer of benzene hexachloride and 'Aldrin' have, in contrast to DDT and 'Dieldrin', a marked fumigant action against *A ægypti*, and there is ample evidence to show that the residual toxicity after the disappearance of crystals from the surface of blocks treated with these insecticides is due to the fumigant effect from the material inside the block Desorption of the volatile insecticides takes several months for completion as compared with a few hours for the sorption process

Crystals of gamma-benzene hexachloride persist for a much longer time on non-absorbent materials, such as glass and metal plates, than on mud blocks , but toxicity is completely lost as soon as the crystals disappear from the surface Sorption of gamma-benzene hexachloride occurs on such materials as plaster fibreboard and unpainted wood, but to a much less extent than on mud blocks

Commercial wettable powders and oil-bound suspensions of these insecticides behave in the same way as the pure materials on Uganda mud Similar results are obtained with soil from Taveta in Kenya and with Oxford, Weald and Gault clays from Britain It is intended to test other soils used in the construction of houses in other tropical countries as soon as the materials are available

These results are of obvious practical importance in the control of adult mosquitoes in houses the walls of which are constructed of dried mud The difference in effectiveness of DDT and benzene hexachloride wettable powders against *Anopheles gambiæ*, Giles, in houses with mud walls in Africa may be accounted for partly, at least, by the rapid sorption of both insecticides into the wall, resulting in one case in a complete loss of toxicity and in the other a persistent fumigant effect Residual effects obtained with DDT wettable powders in houses of this type may be due only to the deposit on the roof Variations in the persistence of insecticides on different types of material may help to explain the conflicting results reported in field-trials against malaria vectors in different parts of the world Sorption of insecticides may be of significance in treatments against soil insects and in soil fumigation

It is intended to publish a full report on these experiments

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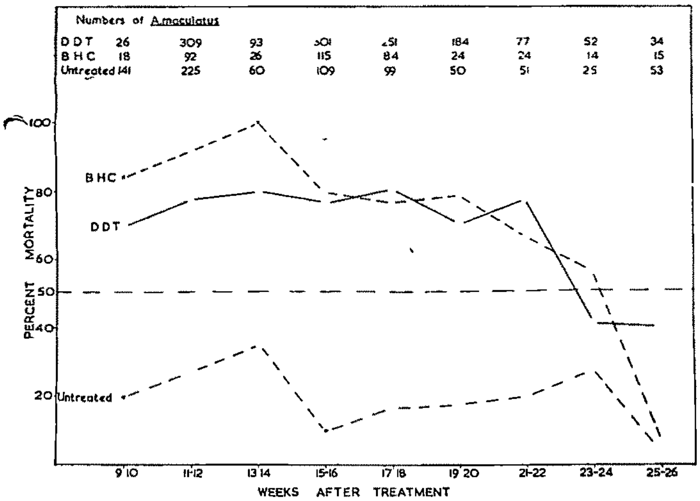
DDT and BHC as Residual Insecticides in Malaya

An earlier report[1] described the effects of the residual insecticides DDT and BHC ('Gammexane') on *Anopheles maculatus* and *Culex fatigans* entering experimental huts fitted with window traps, following the method employed by Thomson[2] *A maculatus* was killed by wettable powders of both DDT (200 mgm /sq ft) and BHC (40 mgm gamma isomer/sq ft) for at least twelve weeks after application DDT killed few *C fatigans*, the majority being irritated and driven out of the hut without feeding , BHC had the same effect but also killed large numbers for several weeks Owing to reduced numbers of mosquitoes entering the huts over the later weeks of the experiment, no information was obtained on how long these doses of DDT and BHC would continue to kill *A maculatus* For this reason the experi-



48-hr mortality of *A maculatus* entering treated and untreated experimental huts DDT, 200 mgm /sq ft , BHC, 40 mgm gamma isomer/sq ft

ment was repeated in 1950 using wettable powders at the same doses, the insecticides being applied in January so that the deposits would be ten to twenty weeks old during March, April and May, the period when a seasonal increase in numbers of *A maculatus* occurs in Malaya

In most respects the results confirmed the findings of the previous year The 48-hr mortality of *A maculatus* trapped in DDT, BHC and untreated huts is shown in the accompanying diagram Taking 50 per cent mortality as the lower limit of effectiveness, it will be seen that both insecticides maintained this standard for 22–24 weeks, that is, nearly six months

The initial mortality of *A maculatus* entering the BHC hut was much lower than in the previous year (8 per cent compared to 66 per cent during weeks 9–12) and the majority were found alive in the window trap Many died in the following twenty-four hours, and a large proportion of those still alive after twenty-four hours died the next day, that is, *maculatus* continued to die up to 48 hr after contact with BHC A similar, though less marked, effect was noticed with DDT

DDT again had practically no lethal effect on *C fatigans*, but continued to drive them out of the hut and reduce the number biting during the twenty-six weeks of the experiment BHC was effective (50 per cent mortality) for only five to seven weeks against this species, and, unlike the previous experiment in 1949, there was little reduction in the biting-rate and mosquitoes were not driven out of the hut

Information on the effective duration of DDT and BHC against *A maculatus* was required primarily as a guide for field experiments in Malay kampongs (rural communities), where these insecticides were being applied, as residual sprays in houses, to control malaria Anophelines in general do not rest in houses by day in Malaya, but pyrethrum knock-down sprays in kampong houses not treated with DDT or BHC showed that *A vagus* and to a lesser extent *A aconitus* could be found regularly Neither species is considered to be a vector in Malaya, and precipitin tests on blood from the specimens caught in this way showed that very few had fed on man For six months after the application of DDT, catches of anophelines in houses remained very low But in BHC-treated houses relatively large numbers of *A vagus* and *aconitus* were obtained by knock-down sprays as early as one month after treatment There were several possible explanations (i) the anophelines might be resting on unsprayed surfaces such as the roof, (ii) anophelines might be resting on sprayed surfaces but would ultimately die from the effect of the insecticide, (iii) *A vagus* and *aconitus* might be less susceptible to BHC than is *A maculatus*, and the insecticide was ineffective against these species one month after application

Mortality of blood-fed females of *A vagus* and *A aconitus* found resting in sprayed and unsprayed houses BHC applied 8–16 weeks earlier at 40 mgm gamma isomer per sq ft

Species	Houses sprayed with BHC			Unsprayed houses		
	Number	Per cent mortality after		Number	Per cent mortality after	
		24 hr	48 hr		24 hr	48 hr
A vagus	143	62	89	196	20	48
A aconitus	30	60	70	41	22	39

Direct observations in BHC-treated houses showed that many of the anophelines were resting on sprayed surfaces, and that the favourite resting-place both in sprayed and unsprayed houses was on the lower portion of the wall usually within 3 ft of the floor There were indications that fewer anophelines were present in sprayed houses during the afternoon than in the morning, and, as is shown in the accompanying table, a considerable mortality was recorded for *A vagus* and *A aconitus* caught by hand in houses sprayed with BHC eight to sixteen weeks earlier

Thus, although anophelines were resting by day on sprayed surfaces, investigation did not suggest that the BHC deposit was ineffective Further observations will be necessary to confirm that the 40 mgm gamma BHC deposit remains effective for six months in kampong houses, but there seems little reason to doubt its effectiveness up to four months One must conclude that the presence of anophelines in houses sprayed with BHC is not in itself proof that the insecticide is no longer potent, just as the absence of anophelines from houses sprayed with DDT or BHC[3] does not necessarily mean that they have all been killed by the insecticide

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Inheritance of Resistance to DDT in the Housefly, *Musca domestica* L.

There have been many speculations on the mode of inheritance of resistance to DDT in the housefly (*Musca domestica* L), but little scientific evidence in support of one theory or another In 1950, Bruce and Decker[1] reported that it was a multiple gene character and was carried by both male and female flies Reciprocal crossing experiments between flies of a non-resistant laboratory strain and a DDT-resistant strain resulted in the F_1, F_2 and F_{15} generations having a resistance exactly intermediate between that of the parents

My experiments on flies of Italian origin, on the other hand, give support to the theory that DDT-resistance is controlled by a single pair of allelomorphs Crossing experiments with four pairs of flies (two reciprocal crosses) gave consistent results The progeny of a cross was exposed to a DDT deposit of 10 mgm /sq ft in glass cylinders, and the time when 'knockdown' occurred in each individual fly noted , in this way the resistance of every individual in the sample was measured

The F_1 generation of a cross between non-resistant and resistant flies had a resistance similar, although not identical, with that of a completely non-resistant strain These hybrid flies were slightly more resistant than the non-resistant strain , but there was no fly comparable with the resistant parent

A clear-cut segregation of non-resistant and DDT-resistant flies is apparent in the F_2 generation , the proportion of non-resistant individuals being approximately 75 per cent The numbers of non-resistant and resistant flies in the F_2 generation of each of four crossing experiments is given in the accompanying table Further support to this theory of single-factor inheritance was given by a backcross between a female fly of the F_1 generation and a resistant male, when the proportion of non-resistant to resistant flies in the offspring was approximately 1 1

Cross	No of non-resistant flies	No of resistant flies	Per cent non-resistant flies	Deviation from expected 3 1 ratio Standard error of expected ratio
Resistant male × non-resistant female	208	85	71	1 58
Resistant male × non-resistant female	211	83	72	1 18
Non-resistant male × resistant female	75	22	77	1 44
Non-resistant male × resistant female	275	93	74 7	0 13

Many workers[2–4] report a 'decline in the resistance' of DDT-resistant strains of houseflies when bred without coming into contact with DDT Since non-resistance is dominant, the proportion of non-resistant flies in the population will increase over several successive generations provided the strain is not composed of resistant individuals only

I wish to thank Prof P A Buxton and Dr J R Busvine for advice and encouragement, Dr J A Fraser Roberts for helpful discussion and also the Medical Research Council for a grant supporting this work

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Heat Tolerance of Cows and Buffaloes in Egypt

An experiment was carried out on the College farm at Giza to study the heat tolerance of buffaloes and Egyptian, shorthorn and Jersey cows A total of 107 females of different ages was used for a period of ten months, from November 1949 until August 1950 Body-temperature, respiration-rate and pulse-rate were recorded twice weekly On each occasion six readings were taken at three-hour intervals starting at 6 a m The animals were grouped according to their age and then subdivided according to their breed The average monthly air temperature ranged from 10 9° C in January to 27 8° C in July, and that of relative humidity from 49 per cent in May to 83 per cent in November

The averages of body-temperature, respiration-rate, and pulse-rate for the adult pure shorthorn were 38 6° C , 17 2 and 31 9 times per 30 sec , for pure Jersey, 38 2° C , 15 3 and 31 0 times per 30 sec , for native cows, 38 2° C , 14 6 and 30 7 times per 30 sec , and for buffaloes, 38 0° C , 12 2 and 28 0 times per 30 sec respectively

The averages of body temperature and respiration-rate were always higher for shorthorn cows than those of Jersey and native cows The buffaloes had the lowest averages of body-temperature, respiration-rate and pulse-rate For all the animals studied, body-temperature, respiration-rate and pulse-rate decreased as they grew older

The increase in air temperature caused an increase in body-temperature and respiration-rate, and a decrease in pulse-rate The increase in the relative humidity resulted in an increase in body-temperature and pulse-rate, while it did not seem to affect respiration-rate except in the case of the shorthorns, in which it caused an increase in respiration-rate also

The help and encouragement of Dr H S Soliman Bey, dean of the College, and Dr A F E Khishin, chairman of the Animal Breeding Department, are acknowledged

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Infectious Pneumonia of Pigs

Pneumonia is more common in the pig than in any other domestic animal Usually 20–60 per cent of pigs killed in slaughter-houses in the United Kingdom and Australia have some consolidation of the lungs In the United States and also in Great Britain, much of the pneumonia in pigs has been thought to be due to the virus of swine influenza, a virus closely related to human influenza *A* virus In addition to its economic importance, influenza in pigs is of interest owing to its connexion with disease in man human strains can infect pigs naturally during epidemics in man[1,2], and it has been reported that pigs may harbour the virus of swine influenza for long periods[3,4] Thus pigs might serve as reservoirs for influenza viruses infectious for man

Using accepted methods of detecting a virus of the influenza group, we have tested pneumonic lungs and sera from a considerable number of pigs in East Anglia, Ireland and Australia. Some specimens were from pigs which died during outbreaks of respiratory disease, thought by practising veterinarians to be swine influenza, whereas others were from pigs killed at slaughter-houses. In no instance was any evidence of an influenza virus obtained.

A type of pneumonia has, however, been transmitted in pigs by intranasal inoculation. Three different lots of inoculum which had been passed through a gradocol membrane, *A.P.D.* 0.8 μ, produced pneumonia, and on ten other occasions transmission was effected with material in which no bacteria could be detected. The disease so produced differed distinctly from swine influenza as described in the United States and as studied by one of us[5], in that the onset was slower, the course more protracted and prostration was much less than in swine influenza. After inoculation, the temperature may first rise and coughing be noticed at any time from the third to the eleventh day, but lesions of pneumonia on autopsy were not observed until more than one week after inoculation. The pneumonic lesions had a characteristic marginal distribution and were usually not extensive. The increase in body temperature was seldom great, and pigs that were afterwards shown at autopsy to have pneumonia usually showed only slight symptoms and continued to eat well. Intravenous inoculation of three pigs with infectious material was followed by a rise of temperature. The infectious agent survived storage at – 20° C. or in glycerol at 0° C. for at least fifty-five days. So far we have not succeeded in infecting chick embryos or laboratory animals, except possibly ferrets, in which an increase in temperature of doubtful significance was produced on three occasions.

We conclude that, at least during 1948–50, influenza has not been common in pigs in the areas studied in the United Kingdom, and that the prevalent form of pneumonia is caused by a filterable organism which is not a member of the influenza group of viruses. Although we have not progressed very far in our investigation of this disease, mainly owing to difficulties in reproducing it consistently, we feel that a useful advance has been made by recognizing this form of infectious pneumonia of pigs as quite distinct from swine influenza, with which it has been confused. Investigation of this disease, which is probably one of the most common diseases of pigs, continues in this laboratory. A detailed account of the research outlined above will be published shortly[6]. Not only did we fail to find evidence that pigs serve as a reservoir for human influenza, but also an investigation carried out by one of us strongly suggested that even the virus of swine influenza does not ordinarily persist for more than about a week after infection[5].

One of us (T. S. G.) is working with a grant from the Agricultural Research Council.

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Pore Canals in a Spider Cuticle

Pore canals have been described in the cuticles of many insects and Crustacea. In the Arachnida less is known of them, but channels containing cytoplasmic filaments have been demonstrated in ticks[1], and vertical striations in the 'exocuticula' of *Tegenaria atrica*[2] have been described and homologized with the pore canals of insects.

In a recent examination of the cuticle of *Tegenaria domestica* (L.) pore canals have been observed in sections of the cephalothorax. They extend from the outer edge of the inner endocuticle and pass through the tanned exocuticle to the amber layer of the epicuticle, which they do not appear to penetrate. In sections of paraffin-embedded material they appear as vertical striæ, the courses of which seem to be deflected in the outer portion of the exocuticle which appears more homogeneous and is more heavily tanned than the inner, laminated portion. All the courses are deflected in approximately the same direction. The significance of this is not clear. Striking information on the structure of the striæ was obtained from tangential sections of the ventral anterior cephalothoracic cuticle to which the chitosan test[3] had been applied. The whole of the exocuticle and the inner endocuticle became purple-red, indicating the presence of chitosan (and therefore in the untreated cuticle of chitin), and the pore canals assumed the same colour but much more intensely, and so stood out clearly from the rest of the cuticle. In these preparations they were not revealed as simple striæ as in the paraffin preparations, for each canal is produced into a number of branches distally, like those of some insects[4–8]. The central part of each canal is expanded and coiled in a loose spiral resembling the pore canals of two-day old third instar larvæ of *Sarcophaga*[6,7], of the cockroach[5] and of adult *Tenebrio*[9]. Proximally the canals become slender again and end at or near the junction of the exocuticle and inner endocuticle.

The fact that they contain chitosan-positive material indicates at once that the canal contents are cuticularized, at least in the later stages of the instar. In stained sections of the cephalothorax directly after the moult, the canals are not visible at all in the endocuticle, which stains with light green or aniline blue, but in sections of the older and partly tanned cuticle they stain with the acid fuchsin of Mallory triple and Masson trichrome stains, so that their courses are easily visible in the inner parts of the tanned exocuticle. In the outermost part of the tanned region they do not seem to stain but appear only as fine dark lines. In fully hardened and darkened cuticles the canals do not stain at all and appear as fine dark lines along the whole of their length. These staining reactions would suggest that in the early stages of the instar the canals have cytoplasmic contents or contain material similar in composition to that of the surrounding cuticle. Later they would appear to be impregnated with some substance of higher iso-electric point (as, in fact, occurs during the hardening and darkening of the exocuticle in which a similar sequence of staining reaction occurs) and finally to be sclerotized, so losing their ability to stain.

In being both chitinized and sclerotized these pore canals closely resemble those of the larva of *Diataraxia*[8]. The pore canals of the adult *Tenebrio*[9] are also sclerotized, but differ from those of *Tegenaria* in that they do not at any stage contain chitin, whereas those of *Sarcophaga* larvæ[6,7] are chitinized but not sclerotized

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Excretion of Yttrium-91 in Rabbits

ESTIMATION of the excretion of yttrium-90 by analysing the decay curves of excreta when a solution of strontium-89, together with strontium-90 and yttrium-90 in radioactive equilibrium, was injected into young and adult rabbits on different diets suggested that the excretion of yttrium was affected by age but not by diet[1] The method of estimation was open to large errors

EFFECT OF AGE ON THE EXCRETION AND RETENTION OF YTTRIUM 91

Age	Yttrium-91 retained per gm of bone (per cent)	Yttrium-91 excreted (per cent)		Yttrium-91 retained in carcass other than bone (per cent)	Total recovery (per cent)
		Urine	Fæces		
5–7 weeks	0 60	10 1	6 3	6 7	84 8
,,	0 62	13 2	3 4	6 3	86 2
,,	0 66	12 6	2 9	5 3	87 3
7 months	0 39	19 6	2 9	9 3	89 9
,,	0 32	23 5	3 4	8 4	87 3
,,	0 27	29 0	3 0	8 4	89 3

The effect of age has been confirmed by actual estimations of both retention and excretion following injection of yttrium-91 (see table) The mean retention per gram of bone in three weanling rabbits five–six weeks old on a medium calcium diet killed nine days after an injection was 0 63 per cent per gm of bone, while in three seven-months old rabbits it was 0 33 per cent of the injected dose per gm of bone The mean excretion in the urine in weanlings was 12 0 per cent of the injected dose, whereas in adults it was 24 0 per cent of the injected dose

These findings confirm that the decay curve method for estimating the excretion of yttrium-90 has validity. They are also of interest since Copp *et al* [2] state that the age of the animal does not affect the excretion and retention of yttrium in rats There is at present no explanation for this apparent difference between the two species

This work was carried out on behalf of the Protection Sub-Committee of the Medical Research Council's Committee on Medical and Biological Applications of Nuclear Physics

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High Concentration of *nor*Adrenaline in Calves' Suprarenals

EXTRACTS of the suprarenal medulla of many mammals, including man, contain both adrenaline and *nor*adrenaline, the latter being present to the extent of about 30 per cent of the total[1] The proportion of *nor*adrenaline in extracts of tumours of the adrenal medulla is much higher[2] It is possible that this difference may be related to the fact that the tumour cells are relatively undifferentiated and thus may be more comparable with embryonic tissue than with adult tissue True embryonic tissue is difficult to obtain, but an opportunity arose recently of examining the suprarenal glands of male calves shortly after birth I am grateful to Dr R S Comline for supplying suprarenals from decerebrate calves The whole suprarenal glands were removed at the end of the experiment and immediately extracted with 0 1 *N* hydrochloric acid in the usual way[3] The extract was assayed against adrenaline on the rat's uterus and against both adrenaline and *nor*adrenaline either on the rat's colon or on the rabbit's intestine A high proportion of *nor*adrenaline was found in every extract, as is shown in Table 1

Table 1 CALVES' SUPRARENALS

	No	Age (days)	*l*-Adrenaline (mgm /gm)	*l*-*nor*Adrenaline (mgm /gm)	% *nor*Adrenaline
Experimental	1	1	1 6	2 6	62
	2	3	0 8	1 9	70
	3	4	2 2	5 4	71
	4	6	1 9	2 3	55
	5	6	1 3	3 9	75
	6	8	0 5	2 5	83
	7	5	1 0	2 7	75
Slaughterhouse	8	>7	6	6 7	51
	9	>7	5	4 6	48
	10	>7	2 5	7 4	74
Mean					66

Since these results were different from those obtained by von Euler[4] with cattle suprarenals, three experiments were performed with whole bullocks' glands from the slaughterhouse The glands were put into ice-cold 0 1 *N* hydrochloric acid about 30 min after death and were taken to the laboratory, where the extracts were prepared and tested The results, which are shown in Table 2, are in agreement with those of von Euler

Table 2 BULLOCKS' SUPRARENALS

No	*l*-Adrenaline (mgm /gm)	*l*-*nor*Adrenaline (mgm /gm)	% *nor*Adrenaline
1	0 94	0 22	16
2	1 25	0 7	36
3	1 75	1 2	41
Mean			31

The suprarenals of three calves were also collected from the slaughterhouse, and results from these are included in Table 1 Comparison of Tables 1 and 2 shows that the proportion of *nor*adrenaline is greater in calves than in bullocks ($P < 0\ 01$) The difference is due to a greater absolute amount of *nor*adrenaline in the calves' glands, the amount of adrenaline in experimental calves is not different from that in bullocks Calves' suprarenals from the slaughterhouse, however, contain more adrenaline ($P < 0\ 01$) and even greater amounts of *nor*adrenaline This may be due to the fact that the animals were older or that they were not used for experiment It is difficult to decide which suprarenals are in the more physiological condition.

The *nor*adrenaline used in these experiments was kindly given by Dr. H. Blaschko of the Department of Pharmacology, Oxford, and Dr. M. L. Tainter of Sterling Winthorp Research Institute.

This work was done during the tenure of a personal grant from the Medical Research Council.

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Zinc Content of the Genital Organs of the Rat

IN a recent review, Vallee and Altschule[1] have suggested that though many workers have estimated zinc in living tissues, the methods used have often been inaccurate. We have estimated the zinc content of certain tissues of the Collip hooded rat by the dithizone method of Vallee and Gibson[2]. Mature animals were used which were fed on a diet of fox chow containing about 75 μgm. zinc per gm., supplemented with carrot and cabbage. Most tissues contained about 15–30 μgm. zinc per gm., but certain male genital organs showed wide deviations from this range. The literature contains few references to the zinc content of the genital system, though Bertrand and Vladesco[3] reported high results in herring's and horse's testis, pig's seminal vesicle, rat's epididymis and in the prostate of the bull and of man. Kadota[4] mentioned briefly that zinc could be detected by a relatively insensitive histochemical method in the rabbit prostate. The figures given by Leiner and Leiner[5] for rat's testis and by Eggleton[6] for human testis were within the usual range for soft mammalian tissues.

The accompanying table shows the results we have obtained with the genital organs of the rat, compared with a selected group of other tissues of the rat. The amount of zinc in the seminal vesicle contents was at the lower limit of accuracy of the method of estimation, and some of the zinc found may have been due to contamination by vesicular tissue juice. There is no doubt, however, that this material contained much less zinc than any other tissue examined. The posterior prostate, on the other hand, contained much more zinc than any other tissue except bone, and, when results were calculated as zinc per gm. ash, the posterior prostate was by far the richest source of zinc in the body. The epididymis also contained a considerable amount of zinc, but the female genital organs gave no striking results.

It is noteworthy that the ventral prostate of the rat contained comparatively little zinc. The fact that the ventral and posterior prostates are very different tissues does not appear to be widely recognized, though they differ not only in gross and histological appearance but also in citric acid and fructose content[7] and in acid and alkaline phosphatase activity[8].

By the courtesy of Prof. Lyman Duff, of Montreal, and Prof. W. L. Robinson, of Toronto, we have been able to examine a number of specimens of human prostate taken at operation and at autopsy. The results, which will be reported elsewhere, were very variable, but most of the apparently normal glandular tissue contained more than 100 μgm. zinc per gm., and one value of 307 μgm. per gm. was observed. Four rabbit prostates contained 173, 233, 270 and 358 μgm. zinc per gm. It seems likely, therefore, that an exceptionally high zinc content is typical of the prostate gland.

ZINC CONTENT OF ORGANS OF THE RAT

Organ	No. of samples	Zinc content of organ (mean with standard deviation)	
		(μgm./gm. wet weight)	(mgm./gm. ash)
Seminal vesicle contents	3	2.15 ± 0.48	0.42 ± 0.09
Seminal vesicle tissue	5	22.1 ± 2.64	1.98 ± 0.30
Posterior prostate	11	180.0 ± 45.5	15.2 ± 3.62
Ventral prostate	9	13.7 ± 3.24	1.49 ± 0.43
Epididymis	8	46.2 ± 4.60	4.36 ± 0.50
Coagulating gland	6	25.0 ± 8.47	2.49 ± 0.81
Testis	7	28.9 ± 1.84	2.68 ± 0.23
Uterus	6	14.4 ± 3.23	1.47 ± 0.33
Ovaries	5	20.3 ± 1.49	1.51 ± 0.23
Brain	5	14.8 ± 1.32	1.06 ± 0.08
Liver	5	30.3 ± 1.57	2.23 ± 0.12
Lung	8	18.7 ± 1.61	1.59 ± 0.16
Submaxillary gland	5	16.5 ± 0.96	1.17 ± 0.06
Pancreas	6	23.3 ± 1.01	1.28 ± 0.16
Duodenum	5	23.9 ± 1.10	1.93 ± 0.28
Diaphragm	5	24.9 ± 2.51	2.17 ± 0.08
Tibia	5	233.0 ± 22.0	0.39 ± 0.05

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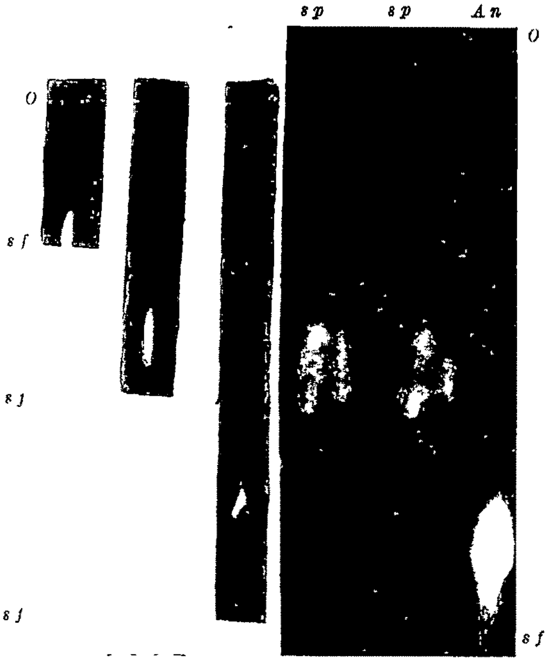
Detection of Enzymes by the Agar-Plate Method and its Application to Paper Chromatography

IN previous publications[1-4] from this laboratory, the use of the agar-plate method for the detection of enzymes has been described. This technique has now been adapted to the location of enzymes on paper. Preliminary investigations have shown that enzymes can be readily identified on the chromatogram by means of this technique.

The filter paper chromatographic experiments were carried out on paper strips (Whatman No. 1, 40 cm. × 12 cm.) by a procedure which resembles in general that developed by Consden, Gordon and Martin[5]. The paper carrying the enzyme near its upper end is hung from a glass trough containing aqueous alcohol or aqueous acetone (50 per cent) as solvent, the whole system being kept in a rectangular-sided glass jar saturated with the vapour of the solvent. After a suitable time of running (5–18 hr.), the paper is removed and the solvent front marked, the paper is allowed to dry at room temperature. The paper chromatogram is then placed on the surface of a thin layer of agar (2 per cent) containing the substrate. After a few hours (2–8 hr.)



(1) (2)

(1) Chromatogram of amylase from *Aspergillus niger* with varying distances of solvent front O, starting point, s f, solvent front (2) Chromatogram of β-amylase from sweet potato (s p) and amylase from *Aspergillus niger* (A n)

to allow the enzyme to hydrolyse the substrate, the agar layer is flooded with a suitable reagent which produces colours with the hydrolysed products A number of substrates for various enzymes are available, which on hydrolysis yield products giving characteristic colour reactions with reagents In the present investigation on the chromatography of amylases, starch (1 per cent) is used as substrate and iodine (N/100) as the reagent for detecting the hydrolysis of the substrate by the enzyme For phosphatases, sodium phenolphthalein phosphate can be used as substrate and ammonia as the reagent, this produces a purple colour with the phenolphthalein liberated as a result of the hydrolysis of the substrate by the enzyme[4] Similarly, urease, lipase, tyrosinase, proteoclastic and other enzymes can be detected on the agar plate

The position of amylases on the paper is indicated by well-defined violet-coloured or clear spots against a blue background on the agar plate, depending on the nature and activity of the amylase (see accompanying photograph) The technique is of value because of its simplicity The position of the enzyme on the filter paper can be distinctly seen on the agar plate and the method is clearly capable of wide application to the study of paper chromatography of enzymes

We have adapted this technique to the study of the behaviour of amylases on the chromatogram The movement of amylases (β-amylase from sweet potato and amylase from *Aspergillus niger*) using aqueous alcohol (50 per cent) and aqueous acetone (50 per cent) as solvent systems has been studied Preliminary investigations have shown that the movement of the enzyme on the paper depends on the nature of the solvent and the distance of the solvent front The R_F values decrease with increase of the distance travelled by the solvent front The R_F value of β-amylase from sweet potato is less than that of the amylase from *Aspergillus niger* Clear and well-defined spots can be obtained when aqueous acetone is used as solvent β-Amylase gives violet-coloured spots, whereas the amylase from *Aspergillus niger* gives colourless spots High concentrations of the enzyme tend to produce a tailing effect Typical R_F values of the enzymes are given in the accompanying table

R_F values aqueous acetone (50 per cent) as solvent

Exp No	Distance of the solvent front (cm)	Amylase from *Aspergillus niger*	Amylase from sweet potato
1	10 1	0 87	
	20 3	0 80	
	35 9	0 77	
2	23 7	0 72	0 61
3	22 9	0 75	0 53

The extension of this technique to the separation of enzymes from one another is being studied

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Production of Diphtheric Toxin of High Potency on a Cystin-free chemically defined Medium

It has been generally admitted that cystin or cystein plays an important part in the growth, especially in the toxin formation, of *Corynebacterium diphtheriæ*[1-6] However, while studying the production of diphtheric toxin on the simplified chemically defined medium which was described in previous communications[7,8], complete replacement of cystin by thioglycollate has been observed without remarkable changes in the bacterial growth and toxin content.

EFFECT OF SODIUM THIOGLYCOLLATE ON THE GROWTH AND THE TOXIN PRODUCTION OF A SUBSTRAIN OF P W No 8 STRAIN (TORONTO HARVARD) IN A CYSTIN-FREE CHEMICALLY DEFINED MEDIUM

Thioglycollate added (gm per litre of medium)	Cystin added (gm per litre of medium)	Final *p*H	Toxin content (*Lf* per ml of medium)	Bacterial growth (mgm *N* per 30 ml of medium)
2 0	0 0	5 4	32	7 33
1 0	0 0	6 6	64	6 99
0 8	0 0	6 4	40	7 65
0 6	0 0	5 4	40	4 85
0 4	0 0	5 8	32	4 06
0 2	0 0	7 0	24	3 08
0 1	0 0	6 6	<4	1 26
0 05	0 0	7 0	0	0 71
0 0	0 0	6 4	no growth	no growth
0 0	0 4	5 4	40	6 05

Results showing the effect of thioglycollate in the cystin-free basal medium are given in the accompanying table It will be seen that the addition of thioglycollate (more than 0 6 gm /l) shows the same effect as that of cystin (0 4 gm /l)

The basal medium used in this work was prepared by my method[7] with careful adjustment of starting pH (7 0) and iron concentration (2 γ/30 ml.), and has the formula

L Asparagine	5 0 gm
DL-Methionine	0 3 gm
Potassium dihydrogen phosphate	5 0 gm
Sodium chloride	4 0 gm
Calcium chloride	1 0 gm
Maltose	12 5 gm
Sodium lactate	1 75 gm
Mueller's II solution (ref 9)	2 0 ml
Distilled water	1,000 ml

After inoculation with the pericle from a four-day ulture of a substrain (adapted to the synthetic medium containing cystin) of Park Williams No 8 Toronto Harvard) strain, and the eight days incubation at 33–35° C, final *p*H, flocculation units and bacterial nitrogen content were measured

It may be concluded that, as source of sulphur, thioglycollate can be utilized as well as cystin by the diphtheria bacillus, at least by the present strain This is consistent with the suggestion from animal experiment[10]

Further research to find the actual mechanism involved is now in progress This will be published in detail later

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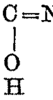
Relation of the Globular to the Fibrous Form of Silk Fibroin

WE have recently stated that if silk II (for example, silk of the cocoon filament[1]) is treated with hot alkali, there appears in X-ray diagrams at the equator one reflexion of 45 A, besides some additional higher orders (silk III[2]) Diagrams of higher-orientated samples show that the net plane with $D = 45$ A coincides with the equator reflexions ($D = 9\ 15$ and 4 57 A), which, as is well known, represent the plane of the flat micelles The 45-A reflexion is much more intense and sharp than the equator reflexions of 9 15 and 4 57 A

Further experiments showed that the following samples of silk could not be transformed into silk III (1) cocoon filaments and films stored for one to two years, (2) films of renatured silk[3,4], (3) films of silk II prepared from a gland which has been stored for some days Silk samples mentioned under (1) give at the meridian diffuse layer-line reflexions of a 21-A period in the first, second and third orders, which after alkali treatment became more intense This effect is apparently the same as that observed by Kratky and Zahn[5] with cocoon filaments treated with nitric acid

Samples mentioned under (1) and (2), even after having been stretched and rolled, show a considerably ower degree of 'higher orientation' Their diffuse small-angle scattering is rather weaker than observed n recent preparations However, the latter show a considerable decrease of small-angle scattering if transformed from silk II into silk III

The ultra-violet absorption[6] shows that the alkali treatment, if carried out at 45° C and within 60 sec, leads to 100 per cent phenolic dissociation of the tyrosyl groups, connected with a transformation of the keto form of some peptide groups into the enolic form Measurements with linear polarized ultra-violet light show that the tyrosine residues absorb more intensely in the direction of the fibre axis (dichroic ratio 1 23–1 26), whereas the additional band of the  $\underset{\substack{|\\ \mathrm{O}\\ \mathrm{H}}}{\mathrm{C}}{=}\mathrm{N}{-}$ groups gives maximal absorption if the vector forms an angle of *c* 40° with the fibre axis The effects of phenolic dissociation and enolization are reversible, and reproducible also with older preparations

Both the X-ray and the spectrographic effect are produced by means of the influence of the hot alkali, but a direct connexion between them cannot be found at present

Also cocoon filaments and untreated films show the intensive 'peptenol' absorption, but films only do so within certain zones which between crossed nicols appear thoroughly homogeneous and have a lower birefringence than the rest of the film On the other hand, the zones gave no characteristically changed X-ray diagram

All the phenomena mentioned above point to the following interpretation The stretching of the native gel consisting of globular units with a molecular weight of 33,000 (cf Coleman and Howitt[3]) leads by means of a two-dimensional aggregation of these units to the formation of lamellæ of uniform thickness The alkali treatment causes a separation of the surfaces After short washing and drying of the alkali-treated samples, the lamellæ apparently remain separated one from another, causing a reflexion which corresponds with their thickness (including the probably very small space between them)

This interpretation explains both the striking sharpness and the high intensity of the 45-A reflexions

The reflexions at the equator corresponding to $D = 9\ 15$ and 4 57 A are not sharp This cannot be due to small dimensions of the crystallites, for lamellæ with a thickness of 45 A should give fairly sharp reflexions An interpretation of the 45-A reflexions as an intramicellar reflexion would presume lamellæ of considerable thickness, that is, extreme sharpness of the equator reflexions far from the centre The fact that reflexions are diffuse points apparently to a deviation from the identity of the 'elementary cells' caused by certain variations from the 'pattern'

Storage of the native silk gel without any loss of the bound water probably gives rise to a change of the globular molecules in such a way that lamellæ of uniform thickness can no longer be formed Thus, the micelles lose more or less their ribbon-like shape and this makes understandable the deficient 'higher orientation' The anisotropy of the small-angle scattering observed if the beam direction coincides with the direction of stretching indicates, however, that some lateral anisotropy of the lamellæ remains Thus, direct evidence is provided for the ribbon-like shape which hitherto could only be identified by means of the appearance of the 'higher orientation'

Storage of silk II also leads to an aggregation of lamellæ of equal thickness so that the hot alkali can no longer separate them The reflexion at 21 A resembling a layer-line might be interpreted simply geometrically as indicating that the lamella consists of beaded strings running parallel with the fibre direction and shifted irregularly with regard to one another within this direction On the assumption that the globular units have a dimension of 21 A in the fibre axis—which seems reasonable in view of the molecular weight of 33,000 and the dimension of 45 A in the side-chain direction—this interpretation could explain the diffuse layer-line reflexion

We are still unable to say why both groups of new reflexions, those at the equator and those at the meridian, exclude one another Furthermore, we wish to emphasize that the other interpretations offered are still somewhat hypothetical Our investigations are being continued

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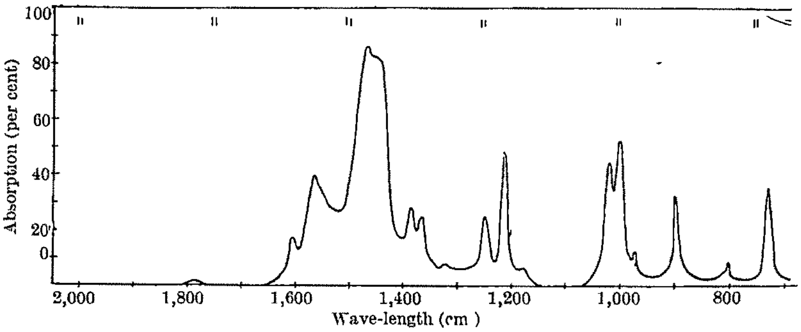
Isolation of 2:3:5:6-Tetramethylpyridine from Coal Tar

DURING an investigation of the nitrogenous bases extracted by sulphuric acid from the 'benzol absorbing oil' fraction of coal tar, a solid base has been isolated which has been proved to be 2 3 5 6-tetramethylpyridine, a compound which has not hitherto been reported as a constituent of coal tar

The solid separated out from a fraction (b 130–132° C /100 mm) obtained by high-efficiency fractional distillation (efficiency approximately 100 theoretical plates) of certain purified coal-tar base samples After repeated crystallization of this solid from petroleum ether, a product was obtained which consisted of small white glistening platelets with a pleasant odour and a melting point of 76° C From this pure product the picrate (m p 176° C), the picrolonate (m p 259–260° C , decomp) and the methiodide (m p 178° C) were prepared

The distillation-range and melting point of this base, as well as the melting points of the derivatives prepared, were found to be identical with those of a tertiary base of the formula $C_9H_{13}N$, which was isolated from the mixed pyridine bases in shale oil in these laboratories by Messrs R J Benzie and J N Milne[1], and mixed melting points showed no lowering Benzie and Milne suggested tentatively that this compound was 2 3 5 6-tetramethylpyridine on the basis of a comparison of its dissociation constant with those of other methylated pyridines, and this was further supported by analogy of the tetramethylpyridines to the tetramethylbenzenes



There are few references in the literature to th preparation of this compound Oparina[2], howeve obtained a solid tertiary base in the reaction produc on passing a mixture of formaldehyde, methyl eth ketone and ammonia over alumina in a heated copp tube This solid base melted at 73–74° C and i picrate melted at 173–174° C This work has bee repeated in this College by R T Smith, who obtaine a solid product which on purification melted at 76° C and the picrate of which melted at 176° C Th mode of preparation of this compound strongl indicates the 2 3 5 6 configuration Mixed melt ing points of the base isolated from coal tar and it picrate with these products showed no lowering

Oparina[3] has recently repeated his earlier work and obtained a product which melted at 81° C and th picrate of which melted at 173 5° C On partia oxidation of this free base with permanganat he obtained 2 6-dimethylpyridine-3 5-dicarboxyli acid, which on distillation with lime yielded 2 6-dimethylpyridine Oxidation with excess perman ganate yielded a crude tetracarboxylic acid which o heating lost carbon dioxide to give an acid meltin at 308–309° C From the mother liquors of the oxidation the 3 5-dicarboxylic acid and 2 5-dimethylpyridine-3 6-dicarboxylic acid were obtained

This work proves quite conclusively that the product obtained by Oparina was 2 3 5 6-tetramethylpyridine, and, on the grounds that their reaction conditions were almost identical, it can be assumed that the product obtained by Smith was also 2 3 5 6-tetramethylpyridine, in spite of discrepancies in the melting points

The infra red absorption spectrograms for the three samples of solid base obtained in this College, which were prepared by Mr J L Hales, of the Department of Scientific and Industrial Research using saturated solutions in carbon tetrachloride/carbon disulphide mixture and a 50-μ cell, were found to be identical and to follow the graph reproduced herewith The graph is corrected for solvent bands

This evidence, together with the evidence of the mixed melting points, is sufficient to prove that these three samples are identical and thus that the solid base isolated from coal tar was 2 3 5 6-tetramethylpyridine

A complete account of this work will be publishe at a later date

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Colour Reaction for Certain Mercaptoimidazoles

In a recent communication[1], I described a new olour reaction for the antithyroid drugs, 2-thiouracil and 4-methyl-2-thiouracil This is based upon the yellow colour which is given when small concentrations of the drugs are treated with 2 6-dichlorounone-chloroimide at *p*H 8 0 Although some free mino-acids, purines and other urinary solutes give coloured products in the reaction, these latter are insoluble in chloroform, whereas within certain concentration limits the coloured products of the rection with the drugs are readily extractable from he aqueous phase by this solvent By this means the olour reaction has been made specific, and has been applied to the colorimetric determination of methylthiouracil in urine

Recently, Stanley and Astwood[2] and others have described the clinical use of antithyroid compounds of the mercaptoimidazole type, which have been hown to have a much higher *in vivo* activity than he thiouracils In view of this we have been intersted in the behaviour of certain mercaptoimidazoles in the above colour reaction, as a potential method or their determination

Compounds of this type examined were 2-mercaptomidazole, 4-methyl-2-mercaptoimidazole, and 4-mino-methyl-2-mercaptoimidazole (hydrochloride) These were dissolved in distilled water, and the *p*H f their solutions brought to 8 0 by the cautious ddition of decinormal sodium hydroxide After uitable dilution, aliquots of the solutions were taken nd mixed with 2 ml of a borate buffer, *p*H 8 0, nd 0 1 ml of a 0 4 per cent solution of 2 6-dihloroquinone-chloroimide in aldehyde-free absolute thanol Colour formation in each case was very apid Once the solutions had stood for 10 min at oom temperature, the solubility of the coloured omplexes in chloroform was determined by shaking ne solutions with 5 ml of this solvent (see table) The amount of compound tested in each case was 5 mgm

Compound	Colour reaction	Solubility in chloroform
2-Mercaptoimidazole	Rapid , deep red	Soluble
4-Methyl-2-mercaptoimidazole	Rapid , deep red	Soluble
4-Amino-methyl-2-mercaptoimidazole	Rapid , orange	Soluble

The sensitivity of the colour reaction for each of the compounds tested was in the region of 10 μgm Of the three compounds tested, the 2-mercaptomidazole and the 4-methyl-2-mercaptoimidazole gave the best results as based upon the stability of their coloured products The 4-amino-methyl-2-mercaptoimidazole gave an orange-coloured product which tended to decompose Imidazole-4-5-diarboxylic acid gave no colour in the reaction

In spite of the preliminary nature of this work, t would appear that other compounds of the meraptoimidazole type would behave analogously in ne reaction, since the introduction of a methyl group t position 4 in the 2-mercaptoimidazole made no ppreciable difference in the colour reaction Since hloroform exhibits a selective solvent action in this nstance, as it does in the case of the thiouracil eaction, it is believed that the colour reaction for he mercaptoimidazoles could be made the basis of useful method for their determination Whether this would be applicable to the determination of the compounds in urine is, of course, based upon whether these are excreted as such A more detailed description of this work will be published elsewhere

I am indebted to Dr W R Trotter, of University College Hospital Medical School, London, for samples of the mercaptoimidazoles used, these were prepared by Dr A Lawson, of the Royal Free Hospital School of Medicine, to whom also thanks are due

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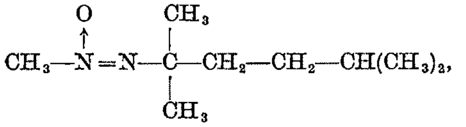
Purely Aliphatic Azoxy Compounds with a Methyl Group attached to the Nitrogen Atom

ALIPHATIC azoxy compounds were first synthesized by one of us in 1931 [1,2], but all contained only tertiary alkyl groups attached to nitrogen

In view of the work being carried out at Cambridge by Lythgoe and collaborators[3] on the natural product, macrozamin, which apparently contains an azoxy group with a methyl group directly attached, it seems worth while to make available our results on the synthesis of an azoxy compound containing such a group

We have synthesized methyl-2-azoxy-2,5-dimethylhexane,



$$CH_3-\overset{\overset{O}{\uparrow}}{N}=N-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-CH_2-CH(CH_3)_2,$$

by the condensation of N-methylhydroxylamine with 2-nitroso-2,5-dimethylhexane by a method similar to that reported by one of us[4]

A suspension was made of 8 0 gm (0 145 mole) of powdered potassium hydroxide in 100 ml of dry ether, and to this was added with stirring over a 20-min period 9 3 gm (0 112 mole) of N-methylhydroxylamine hydrochloride The ether was removed with an aspirator at 60 mm pressure to leave a slightly yellow, curdy solid To this was added at once 16 0 gm (0 112 mole) of *bis*-2-nitroso-2,5-dimethylhexane The mixture was heated to the melting point of the nitroso compound, whereupon a vigorous reaction ensued which required rapid cooling When the reaction had subsided, the mixture was heated to 85° for 1 hr , and then to 110° for an additional 2 hr After cooling, 40 ml of water and 50 ml of ether were added and the layers separated The aqueous layer was extracted again with 25 ml of ether The combined ether extract was dried over sodium sulphate After distilling the ether, the residue was distilled at 35 mm pressure and gave the fractions shown in the accompanying table

Fraction	Vapour temp (° C)	Weight of fraction	Colour of distillate
1	32°– 91°	0 3 gm	Light blue
2	91°–103°	2 3 gm	Very light blue
3	103°–105°	8 7 gm	Light blue tint

Fraction 3 was analysed Combustion analyses gave values of 62 4, 62 5 per cent carbon, and 11 4 per cent hydrogen, calculated values for methyl-2-azoxy-2,5-dimethylhexane are 62 8 per cent C, 11 6 per cent H Molecular weights were 168, 170 for fraction 3 compared with a calculated 172 The yield of methyl-2-azoxy-2,5-dimethylhexane, considering fraction 2 to be mainly this compound, was 11 0 gm (0 064 mole), 57 per cent The refractive index was $N_D{}^{20}$ 1 4330, and boiling point at 738 5 mm was 184° with some decomposition

Reduction with sodium in alcohol yielded the olefin 2,5-dimethyl-2-hexene as the only product isolated

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Improved Spraying Reagents for the Detection of Sugars on Paper Chromatograms

Phenolic spraying reagents for the detection of sugars on paper chromatograms as introduced by Forsyth[1], while greatly improving the selectivity of the method, had the disadvantages that the mineral acid attacked the paper, making it brittle when dried, and giving rise to dark background colours, and that the solvent caused diffusion of the sugar, with consequent poor definition of the spot boundary Partridge[2] found reduced attack on the paper by the use of trichloracetic acid as acidifying agent, and reported improved spot definition with aniline hydrogen phthalate dissolved in butanol[3] Other agents proposed have included aniline hydrogen oxalate[4], aniline – trichloracetic acid[5], benzidine – acetic acid[6], and ethanolic solutions of phenols and amines acidified with small amounts of hydrochloric acid[7]

Experiments carried out in this laboratory have shown that good definition with only moderate attack on the paper can be obtained by using butanol solutions of phenols (0 2 per cent), acidified immediately before use with an equal volume of 0 25 N hydrochloric acid in butanol Tests carried out using phthalic and acetic acids as acidifying agents for phenols showed that these acids were too weak to be effective, but consideration of the relative strengths of acids indicated that phosphoric acid might prove suitable This acid has been used by de Whalley[8] for the detection and estimation of raffinose Chromatograms were prepared carrying rhamnose, xylose, arabinose, dextrose, galactose, mannose, lævulose, sorbose, sucrose, maltose, lactose and raffinose, using upward development in n-butanol ethanol water (4 1 5) These were sprayed with 0 2 per cent ethanolic solutions of resorcinol, naphthoresorcinol, orcinol, alpha-naphthol and phloroglucinol, each reagent being acidified with (i) an equal volume of 0 25 N hydrochloric acid, and (ii) 0 1 volume of orthophosphoric acid (1 85 sp gr.)

In each case acidification with phosphoric acid increased the number of sugars detectable by the reagent For example, naphthoresorcinol – hydrochloric acid showed only lævulose, sorbose, sucrose and raffinose, whereas phosphoric acid brought up all the twelve sugars mentioned Partridge[2] noted that pentoses could be detected by naphthoresorcinol on heating the sprayed chromatogram in a moist atmosphere, and it was observed when using phosphoric acid that the papers always felt damp after heating, the enhanced effects found may be due to the hygroscopic nature of this acid The spot definition was good with phosphoric acid in ethanol but in general no improvement resulted from preparing the reagents in butanol With alpha-naphthol butanol reduced both the range of the reagent and the clarity of the spots

A reagent prepared by mixing butanol solutions of 2 N aniline (1 volume) and 2 N phosphoric acid (2 volumes) showed an increased range over aniline hydrogen phthalate, all twelve sugars again being detectable

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Inorganic Analysis by Paper Ionophoresis

Since the description of the electrophoresis of amino-acids by Wieland and Fischer[1] several workers[2,3] have made observations on the ionophoresis of inorganic ions inside filter paper However, these studies were purely theoretical and did not indicate the possibility of separating inorganic ions for analytical purposes Preliminary work in this laboratory[4] has shown that with the use of 1 N hydrochloric acid as electrolyte and 70 volts, a number of mixtures of metal ions can be separated into three fractions anionic, cationic and isoelectric

In this communication further experiments along these lines are described which indicate that separations analogous to those obtained by paper chromatography are possible by the use of ionophoretic techniques

The technique employed was essentially that of Durrum[5] A strip of paper 1 cm × 20 cm is hung over a T-shaped glass rod so as to hang with its ends in one limb of U-tubes filled with the electrolyte and the whole is covered with an inverted gas jar Carbon electrodes are placed in the other limb of the U-tubes and connected to a source of D C of 70–150 volts The solution to be analysed is placed at the apex of the paper strip and the paper strip moistened carefully with electrolyte solution Current is passed for two to three hours, the paper removed and held in hydrogen sulphide or other suitable reagent

In the earlier communication[4], it was noticed that the copper group cations could be resolved into three bands, namely, copper–cadmium–lead, bis nuth and mercury, by the use of 1 N hydrochloric acid By trying various concentrations of the acid it was found, however, that when 0 5 N was employed a separation of all the metals occurs, and also that the order of separation is the same as for a paper chromatogram with butanol containing hydrochloric acid A typical ionophorogram run with 120 V for two hours gave the following bands Cu^{2+} travelled towards the cathode, front 22 mm , rear 6 mm , Cd^{2+} and Pb^{2+} form overlapping zones from -2 mm to $+6$ mm. , Bi^{3+} travels towards the anode, front band 22 mm , rear 12 mm , and Hg^{2+} travels faster towards the anode, front 31 mm , rear 25 mm (All distances were measured from the apex)

Formation of complexes such as thiocyanate complexes can also be employed for electrophoretic separation Thus a mixture of cobalt and nickel can be separated already after one hour at 120 V if a 7 per cent solution of potassium thiocyanate in 66 per cent ethyl alcohol is used as the electrolyte A blue band of the cobalt thiocyanate complex moves rapidly towards the anode, while a colourless band of nickel moves slowly towards the cathode

Analogous separation by paper chromatography was obtained by E C Martin[6] using butanol containing thiocyanic acid as solvent

These two examples strongly suggest that, for every paper chromatographic separation of ions, equally efficient ionophoretic procedures are possible Further work on this subject is in progress, and the relative merits of paper chromatography and ionophoresis will be investigated

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Thermodynamic Equilibrium

IN previous communications[1,2] under this title, it was shown that the general chemical condition for equilibrium of a closed system can be obtained very simply by distinguishing between the internal and external work done by its forces

For a complete discussion of thermodynamic equilibrium a rather more detailed analysis is necessary The molar changes which may occur are in general of two kinds, namely, 'external' changes (dn_e), due to addition of material from outside, and 'internal' changes (dn_i), due to chemical reactions and movements within the system The total change in the number of gram molecules is then given by $dn = dn_e + dn_i$ for each molecular species, and a closed system may be defined by $dn_e = 0$ for all constituents An external change is restricted to those regions which are accessible from the surroundings across boundaries which define the extent of the system, and must be regarded as a transfer of material from outside across a boundary but no further, unless internally operating forces are absent Also, there may be a force, X_b, in the surroundings but close to the boundary, which may do work, $X_b.dx_b$, when an external change takes place, and it is easy to show that the relation

$$\mu\, dn_e = \mu'\, dn_e + X_b\, dx_b$$

must be satisfied whenever a constituent reversibly enters the system Here μ' is the chemical potential of the constituent in the surroundings beyond the range of action of the boundary force A boundary force must operate, however, before the entry occurs, since any motion after entry has occurred is an internal change and any work which accompanies it is done by internally operating forces, X_i. Hence it is not necessary to include the boundary forces in the energy equation given below Thermodynamically, they do not belong to the system but to the surroundings, and their existence and value depend entirely on where we choose to place the boundary line

It follows that all possibilities are allowed for when equation (1) of my first communication[1] is written in the form

$$dE = T\,dS + \Sigma\mu\, dn_e + \Sigma\mu\, dn_i - \Sigma X_i\, dx_i - \Sigma X_e\, dx_e$$

In case the same force operates both internally and externally, it must, of course, appear twice in the above Moreover, the law of conservation of energy requires that the purely internal changes must sum to zero Hence, $\Sigma\mu\, dn_i = \Sigma X_i\, dx_i$ is always true A system will generally comprise certain restraints in the form of barriers such as container walls, membranes, or partitions, all of which may be fixed or movable These limit the possible composition changes and restrict the performance of work by the forces of the system but do not prevent the flow of heat If, then, we exclude the possibility of perfect thermal insulation or of forces which oppose the flow of heat, we may describe thermodynamic equilibrium as a state of balance, subject to non-thermal restraints, which satisfies the following conditions of equilibrium (1) *Condition for no thermal change* The temperature of the system must be uniform throughout and equal to that of the surroundings (2) *Condition for balance of forces* Any external force capable of doing work on the system must be balanced by an externally operating force (X_e) of the system This will apply both to the system as a whole and to any portion of it (3) *Conditions for no chemical change* As previously explained, for any possible virtual change, we must have, for the internal molar changes,

$$\Sigma\mu\, dn_i = \Sigma X_i\, dx_i ,$$

and for each possible external change at a boundary between system and surroundings,

$$\mu\, dn_e = \mu'\, dn_e + X_b\, dx_b$$

In case the system is a closed one, these reduce to

$$\Sigma\mu\, dn = \Sigma X_i\, dx_i,$$

as previously given

In this simple way, the chemical potential first introduced by Gibbs provides the key to all chemical aspects of the problem of thermodynamic equilibrium It should be emphasized, however, that true thermodynamic equilibrium exists only when all the above conditions are simultaneously satisfied, and in particular the chemical conditions cannot be expected to hold unless the physical conditions are also satisfied Further, any thermodynamical equation which is true only for reversible changes may also be regarded as a condition of equilibrium, and the conditions to which attention is directed here are simply those which directly describe the state of balance

In certain electrochemical problems, for example, the illustrative example of the first communication[1], the consideration of individual barrier potential differences and of the chemical potentials of individual ions may be required Since these cannot be measured, it is general practice to adopt conventional values These are based upon the 'hydrogen scale', which takes the potential of the standard hydrogen electrode as zero, ignores metal–metal contact potentials, and attempts when necessary to eliminate liquid-junction potentials by means of salt bridges So far as these conventional values are precise, they must be thermodynamically consistent, and in particular they must satisfy the conditions of equilibrium described above The individual potential differences mentioned in my first communication[1] are to be understood as conventional values of this kind, since the metal–metal contact potential difference was not mentioned

G A Elliott

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Dec 20

[1] *Nature*, **165**, 934 (1950)

[2] *Nature*, [**166**, 962 (1950)]

Transient Creep in Pure Metals

When an annealed pure metal is loaded beyond the yield point, the deformation continues after the load is applied The strain/time graph is called the creep curve At constant stress Andrade[1] has shown it consists of the strain on loading, followed by decelerating or transient creep and finally steady-rate creep Meissner, Polanyi and Schmid[2] have observed transient creep at the lowest temperatures , steady-rate creep occurs only at high temperatures

Andrade[1,3] and others[4,5] have found the transient creep curve to fit

$$\varepsilon = \beta t^{1/3} + c_1 \qquad (1$$

But Phillips[6] and others[7,8] have used

$$\varepsilon = \alpha \log t + c_2 \qquad (2)$$

I have measured creep curves at constant stress using a new machine with pneumatic loading and continuous strain recording The load could be applied rapidly and readings taken within a second of loading A high sensitivity to strain (2×10^{-5}) combined with a large strain range (10 per cent) permitted measurements over a wide range of stresses and temperatures (– 196° C to 170° C) I have tested polycrystalline copper, aluminium and cadmium , and also aluminium with only a few grains per specimen

I find for each metal that at low temperatures the creep curve is given by equation 2 and at higher temperatures by equation 1 In an intermediate range of temperature, which is lower for higher stress, the creep curve fits

$$\varepsilon = \alpha \log t + \beta t^{1/3} + c_3 \qquad (3)$$

The transition from equation 1 to equation 3 with copper is shown in Fig 1 At the lower temperatures, the strain/log(time) curve is approximately linear At higher temperatures it becomes concave upwards, especially at later times If the α-component given by a tangent to the first part of the curve is subtracted from the total strain, the difference is linear with $(t)^{1/3}$, as shown in Fig 2

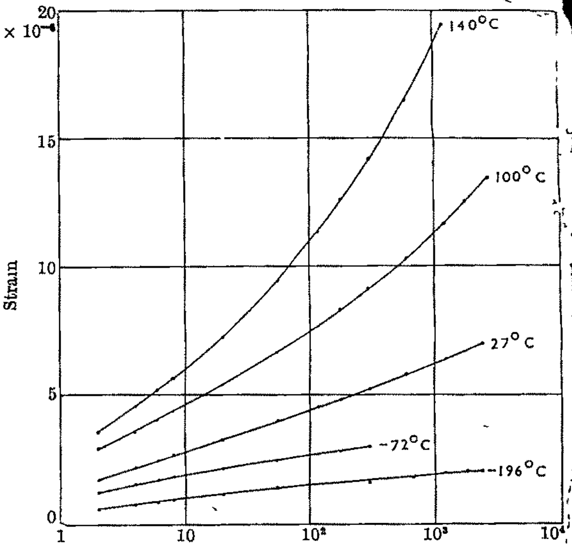

Fig 1 Creep of copper at 18 kgm /mm ^{2} at various temperatures The total strain at 2 sec , from the top curve to the bottom, is 116 99, 86, 72 and 60

Theories have been given by Orowan[9] and Smith[10], which give equations 1 and 2 respectively Orowan[9] and Los showed experimentally that pure metals do not obey a mechanical equation of state, that is, $F(\sigma, \varepsilon, \varepsilon, T) = 0$, and Orowan claimed his theory avoided one

I have altered the stress by small amounts at various times during a creep curve and also changed the temperature between tests on one specimen at increasing stresses I find that when α-flow alone is present, an equation of state is obeyed , but this fails when β-flow occurs

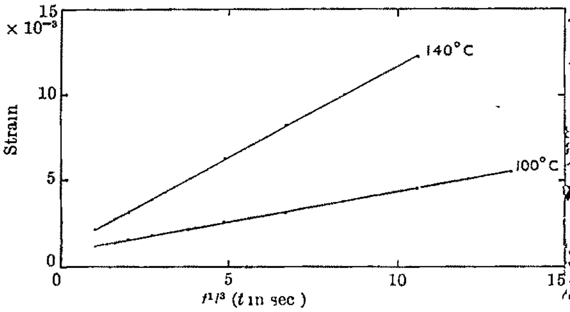

Fig 2 β-Component of creep curves in Fig 1

This has led to a theory of α transient creep in which Smith's exhaustion theory is applied to a strain-hardening material , an equation of state is implicit β-flow is not yet fully understood, but it seems to be connected with recovery rather than strain hardening as suggested by Orowan

O H Wyatt

Cavendish Laboratory,
Cambridge Jan 11

[1] Andrade, E N da C , *Proc Roy Soc* , A, **84**, 1 (1910)

[2] Meissner, W , Polanyi, M , and Schmid, E , *Z Phys* , **66**, 477 (1930)

[3] Andrade, E N da C , *Proc Roy Soc* , A, **90**, 329 (1914)

[4] Andrade, E N da C , and Chalmers, B , *Proc Roy Soc* , A, **138**, 348 (1932)

[5] Cottrell, A H and Aytekin, V , *J Inst Metals*, **77**, 389 (1950)

[6] Phillips, F , *Phil Mag* , **9**, 513 (1905)

[7] Chevenard, P , *Rev de Metall* , **31**, 473 (1934)

[8] Laurent, P , and Eudier, M , *Rev de Metall* , **47**, 39 (1950)

[9] Orowan, E , *West of Scotland Iron and Steel Inst* (1947)

[10] Smith, C L , *Proc Phys Soc* , **61**, 201 (1948).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 28

YAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London,), at 5 p m —Mr Eric Gordon and Mr P H T Beckett Oxford Expedition to Persia"

ITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture ı, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m H Hamshaw Thomas, F R S "Richard Bradley, a Neglected Biologist of the Eighteenth Century", Mr A J Berry e Aspects of the Early History of Electrochemistry"

Monday, May 28—Wednesday, May 30

ITITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION avoy Place Victoria Embankment, London, W C 2), at 5 30 p m ıference on "Electrical Instrument Design"

Monday, May 28—Wednesday, June 6

IRD WORLD PETROLEUM CONGRESS (at Scheveningen, The e)

Tuesday, May 29

GENICS SOCIETY (at the Royal Society, Burlington House lilly, London, W 1), at 5 30 p m —Prof P E Vernon "Recent tigations of Intelligence and its Measurement" *

IETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Port- 'lace, London, W 1), at 6 30 p m —Annual General Meeting

Tuesday, May 29—Friday, June 1

ITUTION OF GAS ENGINEERS (at the Institution of Civil ıeers, Great George Street, London, S W 1) —88th Annual General ng

Wednesday, May 30

LOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, n, W 1), at 5 p m —Scientific Papers

VERSITY OF LONDON (in the Anatomy Theatre, University e, Gower Street, London, W C 1), at 5 30 p m —Prof H ing (North Carolina) "The Behaviour of Standard Statistical dures under Non-Standard Conditions" * (Further Lectures on 1 and 4)

MICAL COUNCIL (at the Royal Institution, Albemarle Street, on, W 1), at 6 p m —Prof J W Cook, F R S "Chemistry and onquest of Disease" (Chemistry in the Service of Man, 3)

Wednesday, May 30—Friday, June 1

s AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London,) —Annual General Meeting

Thursday, May 31

VERSITY OF LONDON (in the Physiology Theatre, University e, Gower Street, London, W C 1), at 4 45 p m —Dr D J Bell ogical Syntheses concerning Carbohydrate Radicals".* (Further es on June 7 and 14)

Friday, June 1

IETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, OGICAL METHODS GROUP (at the National Institute for Medical rch, The Ridgeway, Mill Hill, London, N W 7), at 2 p m — ner Meeting

TITUTE OF ECONOMIC ENGINEERING (at Ward's Irish House, s Street, London, S W 1), at 7 p m —Mr Winston Rodgers ing Work Study Engineers"

Saturday, June 2

EVISION SOCIETY (at Norwood Technical College, Knight's Hill, n, S E 27), at 10 15 a m —Summer Meeting

APPOINTMENTS VACANT

PLICATIONS are invited for the following appointments on or e the dates mentioned

NIOR FELLOWSHIP IN APPLIED MATHEMATICS—The Registrar, University, Bristol (June 1)

URA DE SALICETO STUDENTSHIP (part-time) for the advancement ncer research—The Academic Registrar, University of London, te House, London, W C 1 (June 1)

CTURER (Grade I) IN PHYSICS—The Clerk and Treasurer, Dundee tute of Art and Technology, 40 Bell Street, Dundee (June 1)

SISTANT (Scientist, Grade II, with a first-class honours degree in ce or the equivalent) TO THE DIVISIONAL CHIEF SCIENTIST—The sional Establishments Officer, National Coal Board, Northern and C) Division, First Floor, Ellison Buildings, Ellison Place, castle-upon-Tyne (June 2)

IEF POLLUTION AND FISHERIES OFFICER (with executive ability appropriate technical qualifications in chemistry, biology or ary engineering)—The Engineer and Acting Clerk, Glamorgan r Board, Old County Police Offices, 68a Cowbridge Road, Cardiff e 2)

NIOR PHYSICS AND MATHEMATICS MASTER at Victoria College —The Secretary, Victoria College Council of Management, c/o ation Division, British Council, 65 Davies Street, London, W 1 e 2)

ASSISTANT CURATOR at the Royal Botanic Gardens, Kew—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 193/51 (June 7)

SCIENTIFIC RESEARCH OFFICER IN THE GAS DYNAMICS SECTION of the Aeronautical Research Laboratories, Fishermen's Bend, Victoria, to assist in the operation of a high-speed (sub-sonic) wind tunnel, and to initiate and to carry out original research—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S W 1 (June 7)

HISTOLOGIST IN THE PHYSIOLOGY DEPARTMENT—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (June 9)

SENIOR PETROLEUM TECHNOLOGIST in the Bureau of Mineral Resources, Geology and Geophysics, Melbourne—The Senior Representative, Division of Industrial Development, Australia House, Strand, London, W C 2 (June 9)

SENIOR RESEARCH STUDENTSHIPS IN ENGINEERING AND METALLURGY —The Registrar, University College, Singleton Park, Swansea (June 9)

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Secretary, Bedford College for Women, Regent's Park, London, N W 1 (June 15)

CHAIR OF GEOGRAPHY—The Secretary, The University, Aberdeen (June 15)

LECTURER IN MATHEMATICS at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (June 15)

LECTURER or ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary of University Court, The University, Glasgow (June 15)

CHAIR OF PHYSICS in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (June 16)

LECTURER either in APPLIED MATHEMATICS or in APPLIED MATHEMATICS with special qualifications in FLUID MECHANICS, and ASSISTANT LECTURERS (temporary) IN PHYSICS and in CHEMISTRY (with special interests in INORGANIC CHEMISTRY)—The Registrar, University College, Singleton Park, Swansea (June 16)

SCIENTISTS, Grade III (with a good honours degree in chemistry, and experience in analytical technique desirable) at the Coal Survey Laboratories at Chester and Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/335 (June 16)

SENIOR LECTURER or LECTURER IN (*a*) PHYSIOLOGY, and (*b*) ANATOMY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (June 16)

PROFESSOR OF MEDICINE at the Lady Hardinge Medical College for Women, New Delhi—The High Commission of India, General Department, India House, Aldwych, London, W C 2, quoting 10/1/A (June 18)

RESEARCH PHYSICIST who will be concerned with investigations in semi-conducting materials and crystal valves—The Professor of Physics, The University, Reading (June 23)

ASSISTANT LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, The University, Reading (June 30)

PROFESSOR OF PHYSICS at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (June 30)

SORBY RESEARCH FELLOWSHIP—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W 1 (June 30)

SENIOR RESEARCH FELLOW (Anthropologist) at the East African Institute of Social Research, Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (June 30)

SENIOR STUDENTSHIP (Permutit Co , Ltd) IN CHEMISTRY, ENGINEERING or CHEMICAL ENGINEERING—The Master, St Catharine's College, Cambridge (July 14)

SENIOR LECTURER IN BOTANY, and a LECTURER IN PHYSICS, at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (August 31)

ASSISTANT DRILLING ENGINEER (with a degree in mechanical or mining engineering or equivalent institute qualifications with practical experience) in the Public Works Department (Geological Survey), Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S W 1, endorsed 'Assistant Drilling Engineer, 4/161'

ASSISTANT LECTURER IN PHARMACOLOGY (including Physiology)—The Registrar, The University, Nottingham

ASSISTANT MECHANICAL ENGINEERS in the Sudan Irrigation Department—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S W 1, endorsed 'Sudan Irrigation (Mechanical) 4/47'

ASSISTANT METEOROLOGIST in the Gold Coast—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27118/50

DEMONSTRATORS IN CHEMISTRY—The Registrar, The University, Nottingham

DEPUTY DIRECTOR OF RESEARCH—The Director of Research, British Scientific Instrument Research Association, 20 Queen Anne Street, London, W 1

GEOLOGIST (with high qualifications and practical experience in mining geology) by the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M 27473 E

GRADUATE ASSISTANT IN THE CHEMISTRY DEPARTMENT—The Principal, Municipal Technical College, Halifax

LECTURER IN ENGINEERING MATHEMATICS in the Department of Engineering Production, an ASSISTANT (Grade A) FOR BIOLOGY, and an ASSISTANT (Grade B) to teach ENGLISH USAGE, mainly to technical students, at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, Wolverhampton

PHYSICIST for research in Electronics Department, and a PHYSICIST with some knowledge of vacuum technique, for extended research programme on thermionic emission—The British Scientific Instrument Research Association, Sira, South Hill, Chislehurst, Kent

SCIENTIFIC OFFICERS by the Division of Atomic Energy (Production) Research and Development Branch (Applied Research), Windscale Works, Sellafield, Cumberland, to undertake research work in the field of inorganic and radiochemistry on problems connected with atomic energy development—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref A R D 3/9

SURVEYOR, and a SURVEYOR-TOWN PLANNER, in Aden—The Director of Recruitment (Colonial Service), 2 Sanctuary Buildings, Great Smith Street, London S W 1

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

British Standard 1689 1950, Fire Buckets Pp 8 (London British Standards Institution, 1950) 2*s* net [73

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Department of Agriculture for Scotland Hill Farm Research Report of the Scottish Hill Farm Research Committee Pp 134+16 plates (Edinburgh and London H M Stationery Office, 1951) 3*s* 6*d* net [73

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Carnegie Trust for the Universities of Scotland Forty-ninth Annual Report (for the Year 1949–50) submitted by the Executive Committee to the Trustees on 26th February 1951 Pp iv+70 (Edinburgh Carnegie Trust for the Universities of Scotland, 1951) [73

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Association of Technical Institutions and Association of Principals of Technical Institutions Statement of Policy on the Future Development of Higher Technological Education Pp 15 (London Hon Sec , Association of Technical Institutions, c/o The Polytechnic, Regent Street, W 1 , Dudley Hon Sec , Association of Principals of Technical Institutions, c/o Technical College, 1951) [153

Other Countries

Bulletin of the Museum of Comparative Zoology Vol 105, No 1 Studies in the Achatinidae, a Group of African Land Snails By Joseph C Bequaert Pp 216+81 plates Vol 105, No 2 Comparative Genital Anatomy of some African Achatinidae (Pulmonata) By Arthur R Mead Pp 217–292+9 plates (Cambridge, Mass Harvard College, 1950) [132

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National Research Council Review 1950 (N R C No 2254) Pp 278+11 plates (Ottawa National Research Council, 1951) 75 cents [132

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Bibliography of Scientific Publications of South Asia (India, Bu Ceylon) No 3 January–June 1950 Pp xiii+84 (Delhi : U Science Co-operation Office for South Asia, 1951)

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Atti del Primo Convegno Internationale di Meteorologia A (Proceedings of the First International Meeting on Alpine Met logy), Milano-Torino 20–23 IX 1950 Pp iii+166 (Mil Istituto Geofisico Italiano, 1951)

University of Tehran . Faculty of Science Publication No The Hodograph Method in Gas Dynamics By Prof A G Gha Pp iv+129 (Tehran University of Tehran, 1950)

Federal Security Agency Office of Education Biennial Surve Education in the United States, 1946–48 Chapter 3 Statistic City School Systems, 1947–48 Prepared by Lester B Herlihy, ass by Clarence G Lind, under the direction of Emery M Foster v+85 (Washington, D C Government Printing Office, 1950) cents

Annals of the New York Academy of Sciences Vol 51, Art Human Engineering By L E Abt and 15 other Authors Pp 1 1278 (New York New York Academy of Sciences, 1951) dollars

New Zealand Department of Scientific and Industrial Resear Apia Observatory, Apia, Western Samoa Annual Report for 1 Pp iii+150 6*s* Annual Report for 1945 Pp iii+146. 6*s* (Welli ton Government Printer, 1950)